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The improvement of the harbor of Aransas Pass, on the coast of Texas, which is being carried on by private enterprise, has resulted in the establishment of a new 11-ft. channel across the bar. About 1,200 ft. of jetty has been built, and it is claimed that another 1,000 ft. will give a 15 ft. channel. The work now in progress is being done by Mr. J. P. Nelson.

A great steel manufacturing plant is to be built at Youngstown, O., at an estimated cost of $1,000,000. The product will be steel billets and slabs, and an output of 1,000 to 1,200 tons daily is expected. The works will be located in the western part of the city, and ground will be broken about Oct. 1. The officers of the company are: President, Henry Wick; Vice-President, H. O. Bonnell, Chief Engineer, Julian Kennedy.

The corner stone of the Hennepin Canal guard lock was laid on Sept. 13.

The Postmaster-General's call for pneumatic tube systems for distributing mail matter in large cities was noted in our issue of Aug. 4. Formal propositions were submitted by the Pneumatic Transit Co., of Philadelphia; the Kelly Pneumatic Tube Co., of Chicago; the Collins Automatic Pneumatic Switching Tube Co., the United States Automatic Dispatch Co., of New York City; the Beach Pneumatic Conveyer Co., of of Chicago, and the Pneumatic Transportation Co., of 109 So. Broad St., Philadelphia. Requests for an examination of their systems were made by Messrs. A. J. Atwater, of Chicago, and H. A. Lewis, of Morristown, Pa. The Postmaster-General appointed his second and third assistants, Messrs. Bell and Hazen, and Mr Maynard, of the Inspection division, to form a committee to examine the various systems, with authority to employ an expert to aid them in their work.

The Chicago Drainage Board discussed on Sept. 14 the proposition to secure temporary relief by discharging the contents of the Chicago River into the Des Plaines River, or the Illinois and Michigan Canal, or both, during progress of work on the main drainage canal. It was held that this could not legally be done, and the matter was dropped, only one member of the Board voting in favor of the proposition.

A convention to discuss highway and drainage laws will meet at Houston, Tex., Oct. 21. The convention will consist of the county judges and county commissioners of the state.

Low-tension arc lamps of 1,000 c. p., are being placed on Fifth Ave., New York city. The current used is of only 110 volts. The lamp is the invention of Mr. E. Bergmann, President of the New York Electric Equipment Co.

Street-paving brick is so much in demand in Illinois that manufacturers are totally unable to meet the demand. The City Engineer of Sterling, Ill., writes us that in a recent call for pavement of this kind only one bid, $2.15 per sq. yd., was received, and rejected as being too high. Many contractors refuse to bid owing to the difficulty of obtaining material. Ottawa, too, is waiting for brick, and Galesburg paving brick makers have just declined to contract for 5,000,000 paving brick for the Chicago Exposition.

Brick paving is to be laid on a street in Springfield, Mass., by the New York Brick & Paving Co., of Syracuse. The contractors guarantee the work for 10 years.

The Baltimore Belt Tunnel is giving so much trouble that we understand it has been practically decided to build an invert for its whole length.

The Krupp 100-ton gun will not be sent to the World's Columbian Exposition after all. The reason is said to be that the firm has been unable to make arrangements with any railway company to transport the heavy weight from New York to Chicago.

The most serious railway accident of the week was a head collision on the Pittsburg, Ft. Wayne & Chicago R. R., Sept. 21. The Chicago Express, at full speed, crashed into a freight train, which was pulling onto the main track from a siding. Both engines and 5 freight cars were wrecked, and hte postal car, two express cars, baggage car, smoker and one coach were destroyed by fire; 10 persons were killed and 9 injured. The fault seems to lie with the engineer of the freight train, who moved off the siding contrary to orders.

Another head collision occurred Sept. 15 on the Chicago & Northwestern Ry., three miles west of Marshalltown, Ia. The colliding trains were an accommodation and a freight. Four men were killed. The collision was due to the giving of wrong orders by the train dispatcher at Belle Plaine.

A third head collision occurred Sept. 21 on the Pennsylvania R. R. at Rheem's station, 15 miles west of Lancaster, Pa. The second section of the westward bound Pacific Express ran into the second section of the Philadelphia Express. One man was killed and one seriously injured. Both engines were wrecked, and the express cars telescoped. The eastbound train had the right of way. The westbound train had been ordered to wait over at Coon's Siding. This siding was crowded with freight cars, and the engineer tried to make the siding at Rheem's.

A passenger train on the Atchison, Topeka & Santa Fe R. R. is reported to have been wrecked by train robbers, three miles west of Osage City on the morning of Sept. 21. The train, consisting of a baggage, express, and mail car, two day coaches, two chair cars, and three sleeping-cars, was thrown over an embankment, and the first six cars were telescoped. Four persons were killed outright and 25 seriously injured.

An examination of the track was made, and it was found that the fish plates had been carefully removed and the bolts taken out and spikes drawn from ten ties, and the rail bent over to the inside.

The investigation of the recent Fitchburg collision by the Massachusetts Railroad Commission seems to show that the dense fog which prevailed not only prevented the engineer of the freight engine from recognizing the brakeman's lantern, but caused him to run past the fixed station signal, which according to the bulk of the testimony seems to have been set at danger. The rear brakeman of the wrecked train testified that he went back with his lantern and torpedoes and fusees. He did not place the torpedoes because the rules for their use mention telegraph poles, and it was so foggy that he could not see the telegraph poles. As the freight train approached he heard two short blasts from its whistle, considered this as answering his signal, and so did not light a fusee.

An engineer on the Pittsburg, McKeesport & Youghiogheny R. R. has been convicted of misdemeanor, fined $100 and costs and sentenced to 48 hours' imprisonment. While running a locomotive on May 1 he forgot his running orders and collided with another train, causing the death of a fireman.

The completion of the new U. S. cruiser "Cincinnati" will be somewhat delayed as the result of a fire in the Brooklyn Navy Yard shops on Sept. 17. The engines for the vessel, which were practically completed, were considerably injured by the flames.

The Phoenix Bridge Co. has brought suit against the Louisville & Jeffersonville Bridge Co. for $291,336 due on account, with interest from May 16, 1891.

Towing timber in rafts is being tried on the Pacific coast. A raft containing 1,500,000 M. ft. B. M. of timber was brought into port at San Francisco on Sept. 11, after a voyage of 132 miles, which was made in about 40 hours. The raft was built by the Fort Bragg Lumber Co., and like the similar ventures of Mr. Jas. D. Leary, on the Atlantic coast, the first attempt proved a failure, the raft breaking in pieces.

An asphaltum mine is being developed at Uvalde, Tex., 75 miles west of San Antonio, on the Southern Pacific R. R. About 25 men are at work.

A New York state canal convention has been called by the Executive Committee of the Union for the Improvement of Canals, to meet in Music Hall, Buffalo, Oct. 19. Mr. Orlando B. Potter is chairman of the Executive Committee and Mr. Frank S. Gardner is Secretary.

A call for a New York State Canal Convention has been issued to "consider the importance of the immediate improvement of the State canals, and to perfect plans and organization to carry such measure into effect." It will be held at Buffalo, N. Y., on Wednesday, Oct. 19.

All organizations of citizens, who favor the improvement of the State canals, representing the commercial, manufacturing, agricultural, labor, transportation and other interests, are invited to send one delegate for each fifty members thereof, or fraction of fifty. All cities, towns, villages and counties are invited to send at least three delegates. Independent meetings to appoint delegates are also invited.

Citizens favoring the object of the Convention are requested to send their names at once to the secretary, Frank S. Gardner, 55 Liberty St., New York.

A range-finder for coast-line defense has been invented by Lt. Isaac N. Lewis, and the first one has been made by the Brandis Manuf. Co., of Brooklyn, and is now set up at Fort Wadsworth, on Staten Island. This range-finder requires a solid foundation as close to the shore line as possible. The semi-circular bed-plate is 11 ft. long and 8 ft. wide, and most accurately planed. An arm pointed at the center and moved by a hand-wheel, carries a telescope, horizontal and depression verniers, pencil, and various bits of mechanism not described. A chart of the harbor is accurately adjusted under the arm, and as the telescope is made to follow a fixed point on the hull of an approaching ship, the movement and position of the ship is traced by the pencil on the chart, on a scale of 1-1000 ins. to 1 ft. Tests made upon buoys 4 and 5 miles distant indicated their true distance within a few inches. The instrument is said to be useful in coast survey work, "as by following the coast line with the telescope an absolutely accurate map can be drawn." But as the iron bed-plate alone weighs 1,800 lbs., and requires a very firm foundation, its use in this direction is not plain.

Irrigation pays roundly, according to the summarized results of a special investigation, made by the U. S. Census Office. In the arid states and territories the cost of the irrigated farms was $77,500,000, and their estimated value, on June 1, 1890, was $297,000,000, or four times their cost.

William Cramp & Sons, the shipbuilders of Philadelphia, have prepared the plans and specifications for the five new steamers of the International Transportation Company, the new American line. The new twin-screw steamers will be about 600 ft. long and their aggregate cost is estimated at from $8,000,000 to $9,000,000. Construction will commence as soon as the Secretary of the Navy has approved the plans, for under the Postal Subsidy Act these steamers are designed with reference to their possible conversion into auxiliary naval cruisers.

Immigration for various periods ending Aug. 31 is reported as follows: The month of September will doubtless show a sharp falling off, and the month of October an almost total cessation, which as respects much of our immigration we hope may be long continued.

	1892.	1891.
Month of August	45,472	45,172
2 months ending with August	94,658	91,263
8 months ending with August	448,619	416,570

Though the aggregate of immigration had thus been nearly stationary, the German immigration showed a sharp increase and the Russian immigration a still sharper decrease (from 8,418 to 4,972) for the month of August. What may be broadly classed as the undesirable immigration, Bohemian, Hungarian, Italian, Polish and Russian (included among whom, doubtless, were many very excellent immigrants) constituted 14,703 or 32.3% of the total.

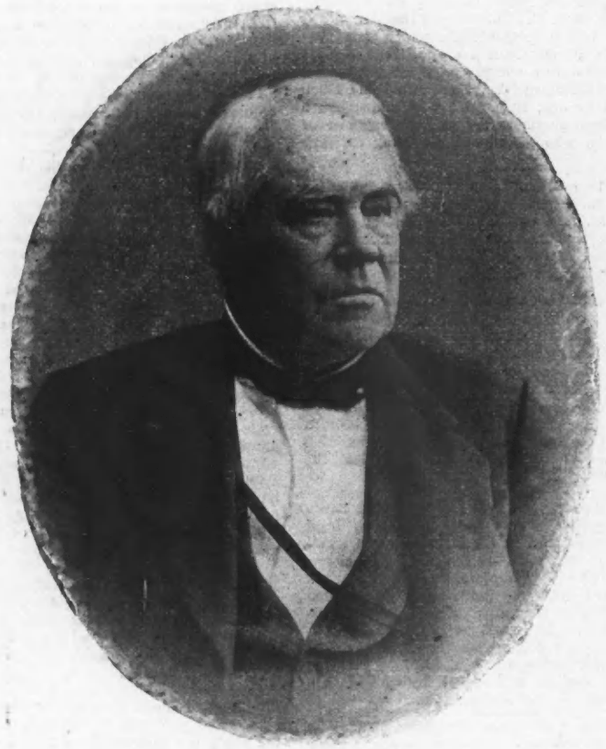
The White Star Steamship Co. has ordered from Harland & Wolff, the Belfast shipbuilders, an Atlantic steamer of the following dimensions: Length, 700 ft.; beam, 65 ft. 7½ ins.; horse power, 45,000. This "Gigantic," as she is already named, is to have an average speed of 22 knots, with a maximum speed of 27 knots, and she is to be fitted with three screws, like the U. S. commerce destroyer "Columbia."

JAMES B. FRANCIS.

Mr. James B. Francis, for nearly 60 years at the head of all hydraulic work at Lowell, Mass., and perhaps the greatest living hydraulic engineer, died in Boston, Sept. 18, aged 76 years and 4 months. He died at a private hospital from the effects of an operation which his state of health had made necessary, but which his remnant of physical strength was not sufficient to sustain.

The announcement will be read with sincere regret and grief by all who knew him, and few engineers had a wider circle of acquaintances and friends within professional circles at least. His life work was done, but his genial presence at meetings of engineers, which he invariably attended when possible, will be sadly missed.

We have already published a portrait and sketch of his life, in our issue of Jan. 1, 1887, but in



Very truly yours
James B. Francis

obedience to what we feel will be a universal wish we reproduce herewith the portrait then published and also add a condensation of the sketch of his life then published, adding a few further facts of interest.

James Bicheno Francis was born at Southleigh, Oxfordshire, England, May 18, 1815. His father was a Welsh railway superintendent, and, influenced by the opening thus afforded him, at the early age of 14 James was engaged in harbor works connected with the railway of which his father was superintendent. At the age of 16 he was engaged upon the Grand Western Canal in Devon and Somersetshire. At the age of 18, in 1833, he came to this country and almost immediately found employment on the Boston & Providence R. R. under Messrs. Wm. G. McNeil and Geo. W. Whistler, its engineers.

The very next year Major Whistler began the extensive hydraulic improvements which were to create the city of Lowell. Mr. Francis was chosen by him as his assistant, and only three years later (1837) when Major Whistler left to build the Western R. R. (now Boston & Albany) between Worcester and Albany, Mr. Francis was appointed Chief Engineer for the Proprietors of Locks and Canals on the Merrimac River, being then only 22 years of age. In the discharge of the duties of this office the whole of his long and honored life was to be passed, until his death as above announced in the 77th year of his age.

In 1845 he was appointed agent of the company as well as Chief Engineer, both of which positions he held until the expiration of the 50th year of continuous service, in 1884, when he resigned from active service, continuing as Consulting Engineer for the company up to the time of his death.

The hydraulic works thus placed in charge of Mr. Francis were then (and almost now) of unprecedented magnitude, and it is needless to say that the existing knowledge of hydraulics at that time was extremely crude and imperfect. Mr. Francis himself may be said to be the father of modern hydraulic engineering. Not only had a great system of dams, conduits and other hydraulic works to be created, for which there were few or no precedents, but there was an early demand for the most accurate possible apportionment of the power to the several mills, as the demand for power was almost from the first greater than the supply. This led to the famous "Lowell Hydraulic Experiments," the results of which were first published in 1855 and republished with additional data in 1868 and 1883. The work chronicled a vast advance upon prior hydraulic knowledge, became at once a standard work throughout the world, and at once placed Mr. Francis' name in the short list of eminent engineers who have materially contributed to the enlargement of engineering knowledge.

Many other signed and unsigned papers were written by Mr. Francis, however, more than 30 of which (including discussions) are credited to his name in the Transactions of the American Society of Civil Engineers. He was also at various times a valued contributor to this and other journals.

Mr. Francis was not only a great experimenter, however, but a sound and cautious engineer and a just and upright man in all his instincts and dealings. These qualities even more than his theoretical knowledge placed him so high in the confidence of his employers that there was never even a thought of either substituting another man in his place or allowing him to leave the service of the company whatever offers might be made to him to go elsewhere. Disputes among the companies in regard to the amount of water used were not infrequent. Many attempted at times and all were suspected of seeking to get more than their fair share. All these disputes, and all the necessary measures to insure fair division, were left with implicit confidence in Mr. Francis' hands, and the task of keeping an even hand between the claimants was no small one.

An incident which early seemed to establish general confidence in his professional judgment was the construction of some costly guard-locks on the Pawtucket Canal, with a view to restraining any exceptional freshet. Before and during this construction they were popularly known as "Francis' Folly," they were so far above and beyond all previous requirements within the memory of the oldest inhabitant, few of whom were very old, as the town amounted to nothing prior to 1821, though it grew rapidly thereafter.

Mr. Francis, however, had obtained a record of a flood in 1785 which convinced him that much larger bodies of water might have to be controlled in order to protect a portion of Lowell than was generally expected. He built the gates in 1850. By a singular coincidence the expected freshet which had been 65 years in getting ready, followed within two years after the gates were completed, April 22, 1852. In recognition of this service Mr. Francis was presented with a massive silver pitcher and salver bearing this inscription:

> "By his neighbors and friends, in token of their admiration of his foresight and sagacity in constructing a gate at the guard locks, thereby effectively protecting the city of Lowell against those casualties to which, as the freshet of 1852 demonstrated, it would be exposed."

The great Northern Canal, constructed in 1846 to secure additional water power, is Mr. Francis' finest single work. It is 100 ft. wide, 15 ft. deep and about one mile long, and cost $530,000.

In addition to his duties in connection with Lowell hydraulic interests, Mr. Francis enjoyed through life a very considerable consulting practice, and in particular enjoyed peculiarly intimate and trusted relations with the textile manufacturers of New England as a consulting engineer, not merely in regard to hydraulic questions and the construction of dams, but also the strength of buildings and the general appointment of motive power.

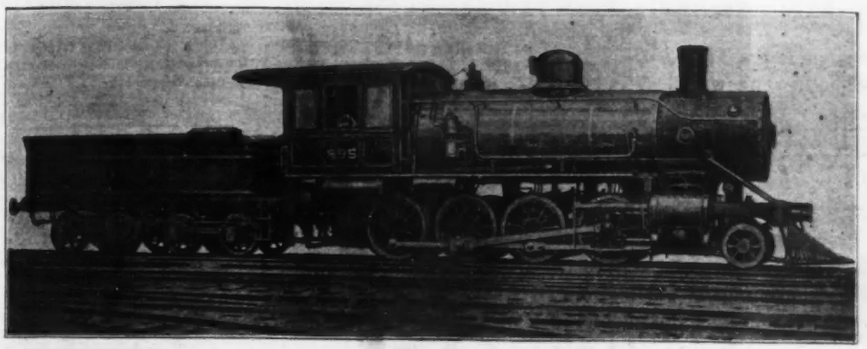
Mr. Francis was one of the three men now living who were original founders of the American Society of Civil Engineers in the sense of having been elected members at the first meeting held, when the society was organized, Nov. 5, 1852. The other two are Julius W. Adams and Gen. Geo. S. Greene, both of whom were present at the little gathering of 12 engineers who constituted themselves the Society and at the same time elected a few others not attending, among whom were Jas. B. Francis, Jas. P. Kirkwood and G. M. Dexter. If there were any others than these three then elected, outside of the 12 men present, they dropped out of the society before their death, as their names do not appear in the roll of deceased members. Mr. Francis, being one of the younger men of this group, was not elected President of the society until 1880, being the eleventh man to receive that honor, of whom only three now survive—Messrs. J. W. Adams, Geo. S. Greene and Albert Fink. Of the ten men who succeeded him in that office, three have since died and seven now survive.

Mr. Francis is survived by his widow, by three sons, Col. Jas. Francis, of Lowell, and Charles Francis, of Davenport, Ia., both engineers, and Dr. Geo. Francis, of Worcester, and by one daughter. The funeral was at St. Anne's Episcopal Church, Sept. 21, of which church Mr. Francis had been a member for the greater part of his life. His funeral was largely attended by engineers and citizens of Boston and Lowell.

A report on the removal of grade-crossings at Atlanta, Ga., has been made by Mr. E. L. Corthell, under date of Sept. 13. He recommends elevating the tracks above the streets, concentrating all the railways in a large union passenger station, and providing a union freight terminal.

AMERICAN LOCOMOTIVES FOR NEW SOUTH WALES.

The discussion which has been going on over the merits of the American locomotives for the New South Wales Government railways, and the performance of these engines, have been presented very fully in our columns, and the official report of the committee appointed to investigate the facts as to these engines was given in our issue of Aug. 18. This report showed clearly that the engines were entirely suitable to the colonial railways and that their performance was fully up to the requirements. We now give views of the two classes of engines, and a tabular summary of their dimensions, etc., for which we are indebted to the builders, the Baldwin Locomotive Works, Philadelphia, Pa. There are twelve ten-wheel passenger engines, and ten consolidated freight engines, two of the latter being compound engines of the Vauclain four-cylinder system described in our issue of Feb. 20. The railways are standard gage. The engines were built in 1891, and burn soft coal. They are all fitted with the English Westinghouse air brake, with American Brake Co.'s equalized driver brake.



Compound Consolidation Locomotive for New South Wales Government Railways; Baldwin Locomotive Works, Builders.

The compound consolidation engines are identical with the simple, with the following exceptions:

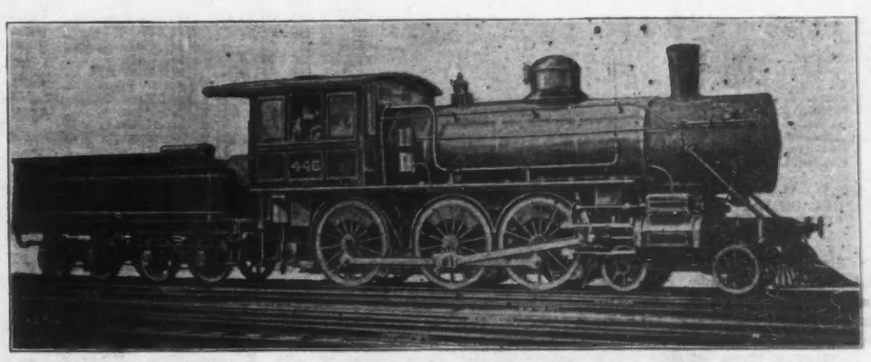
	Compound	Simple
Cylinders	{ h. p. 13½ × 26 ins. / l. p. 22 × 26 ins. }	21 × 26 ins.
" ratio of h. p. to l. p.	1 to 2.65	.....
Ports, length	21¾ ins. diam.	19 ins.
" width of steam	1½	1⅝
" width of exhaust	3	3
Valves	piston	slide
" lap	{ h. p. ¾ in. / l. p. ⅝ " }	¾ in.
" lead	{ h. p. ⅛ " / l. p. ⅜ " }	⅛ in.
" max. travel	5 ins.	6¼ ins.

The ten-wheel engines have two bar guides of the open pattern, requiring a very high crosshead. The compound consolidation engines have the same pattern of guides, which with the two piston rods between them involves the use of an extremely high crosshead. A later and more compact arrangement for the guides of the Vauclain compound engines has the guides between the piston rods, the crosshead being a top and bottom lug, to which the piston rods are connected, as illustrated in our issue of Feb. 20, 1892. The simple consolidation engines have the Laird guide, with underhang crosshead. The engines and tenders have spring buffers of the English type. The front and rear sand boxes are placed under the running board. The tenders have spoke wheels. The following table gives the dimensions of the simple ten-wheel and consolidation engines:

	Ten-wheel.	Consolidation.
RUNNING GEAR: No. of drivers	6	8
No. of truck wheels	4	2
Driving wheels, diam.	61 ins.	51 ins.
Truck " "	30	30
Tender " "	36	36
Engine truck, length of radius bar	.....	5 ft. 8 ins.
Engine truck, swing or rigid center	Swing	Swing
Journals, driving axles 8 ins. dia.	× 8½	8 × 8½
" truck axles	6 × 10	5 × 10
" tender axles	4 × 8	4 × 8
WHEEL BASE: Driving	12 ft. 6 ins.	14 ft. 3 ins.
Truck	6 ft.	.....
Total engine	23 ft. 4 ins.	22 ft. 4 ins.
" tender	14 ft. 1 in.	14 ft. 1 in.
" engine and tender	48 ft. 1½ in.	48 ft. 3½ ins.
C. of truck pin to c. of leading driver	7 ft. 10 in.	8 ft. 1 in.
Drivers having blind tires	2d pair	2d and 3d pair

WEIGHT in working order, on drivers	97,000 lbs.	118,810 lbs
On truck wheels	28,000 "	19,310 "
Engine, total	125,000 "	138,120 "
Tender, " (est.)	82,800 "	82,8 0 "
Engine and tender, loaded	207,800 "	220,920 "
Tender, empty (est.)	37,812 "	37,812 "
Of full coal capacity	15,000 "	15,000 "
Of full water capacity of tank	29,988 "	29,988 "
Allowed for water in boilers	16,000 "	18,160 "
CYLINDERS	21 × 24 ins.	21 × 26 ins.
Dist. c. to c.	7 ft. 2 ins.	7 ft. 1⅛ ins.
" c. to valve fall	1 " 6¼ "	1 " 6¼ "
Piston rod, diam.	3½ "	
Crosshead and guides (2 bar guides)	Open style	Underhung crosshead.
Converting rod, length between centers	9 ft. 1⅞ ins.	9 ft. 7¾ ins.
VALVE GEAR; type	Shifting link	
Ports, length	19 ins.	19 ins.
" width steam	1⅝ "	1⅝ "
" width exhaust	3 "	3 "
Slide valves, lap	⅞ "	⅞ "
" " max travel	6¼ "	6¼ "
" " lead	⅛ "	¼ "

BOILER, type	Straight	Straight
Diam. of barrel inside, average	5 ft. 2 ins.	5 ft. 4 ins.
Thick. of barrel plates, steel	9/16 ins.	5/8 ins.
Thick smoke box tube plate steel	½ "	½ "
Height from rail to c. line	7 ft. 9 ins	7 ft. 10 ins.
Length of smokebox	6 " 4¾ ins.	6 " 4¾ "
Working steam pressure	160 lbs.	160 lbs.
FIREBOX, radial stayed	{ Between frames	{ On top of frames
Length inside	10 ft. 0 ins.	9 ft. 4 ins.
Width inside	2 ft. 9⅛ ins.	3 ft. 6 ins.
Depth at front	6 ft. 1 in.	5 ft. 2¼ ins.
Depth at back	4 ft. 8 ins.	4 ft. 10½ ins.
Thickness of side plaest (copper)	½ in.	½ in.
Thickness of back plate (copper)	½ in.	½ in.
Thickness of crown sheet (copper)	½ in.	½ in.
Thickness of tube sheet (copper)	⅝ and ½ in.	⅝ and ½ in.
Grate area	27.9 sq. ft.	32.65 sq. ft.
Ratio of area to heat surf.	1.39%	1.95%
Staybolts (copper), diam.	1 in.	1 in.
Staybolts, pitch	not over 4 ins.	
Water space, width	4 ins. front, 3 ins. side and back increasing upward.	



Ten Wheel Locomotive for New South Wales Government Railways; Baldwin Locomotive Works, Builders.

TUBES (brass), number	270	231
Pitch	2⅝ ins.	2⅝ ins.
Diam. outside	2 ins.	2¼ ins.
Length betw. tube plates	12 ft. 10⅝ ins.	13 ft. 3½ ins.
Total fire area of openings	4.95 sq. ft.	4.83 sq. ft.
HEATING SURFACE.—Ratio of firebox heat. surf. to ext. tube. area.	9.3%	8.75%
Tubes, exterior	1,811.5 sq. ft.	1,809 sq. ft.
Firebox	169 " "	158 " "
Total with exterior tube area.	1,980.5 " "	1,967 " "

MISCELLANEOUS.—Exhaust nozzle double, with changeable thimbles rom 3½ ins. to 4¼ ins. diam.

Smoke-tuck, smallest diam.	1 ft. 6 in.	1 ft. 6 in.
" height from rail to top	13 ft. 6 ins.	13 ft. 6 ins.
Capacity of tank	3,600 gals.	3,600 gals.
Capacity of coal space	15,000 lbs.	15,000 lbs.
Tractive force per lb. effect, pressure on piston	173.5 lbs.	224.82 lbs.
Total tractive force with effect press. = ¾ of boiler press	22,308 lbs.	28,777 lbs.
Total adhesive tractive power at ¼ of weight on driver	24 250 lbs.	29,702.5 lbs

The locomotives built by the Baldwin Locomotive Works, Philadelphia, Pa., for the New Zealand government railways were described and illustrated in our issue of Nov. 14, 1891.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Conclusiveness of Government Survey.

In establishing section lines, corners shown to have been originally made by Government surveyors are conclusive, and shall be accepted as the true corners, no matter how inaccurately they may have been originally established. If witness trees or other government monuments are known or found, and identified, the corners to which they refer must be ascertained by reference to them, and not by the regulations provided for establishing lost corners. The identity of these Government corners, or of the monuments bearing witness to them, can be shown by the testimony of any one having knowledge of the fact, and does not depend for proof upon the record of a survey by a county surveyor. (Mayor, etc., of the town of Liberty, v. Burns. Supr. Ct. Mo., 19 S. W. Rep., 1107.)

Injunction Against Grade Crossings.

Under a statute which declares that railroad companies organized thereunder "shall have the right to construct roads so as to cross at grade the track or tracks of any other railroad," and another statute provides that it is the duty of courts of equity "to ascertain and define by their decree, the mode of crossing of railroads which will inflict the least practical injury on the rights of the company owning the road which is intended to be crossed; and if, in the judgment of such court, it is reasonably practical to avoid a grade crossing, they shall by their process prevent a crossing at grade." Where a company's railroad is so constructed as to cross another railroad twice within four miles, and it would be practical to so locate its route as not to cross it at all, the former will be restrained from crossing defendant's road at grade. (Perry County R. R. Extension Co. v. Newport & S. V. R. R. Co., Supr. Ct., At., Rep., 709.)

Injury Caused by Washout.

In an accident against a railway company to recover damages for personal injuries it was alleged that the accident was caused by the company's negligence, (1) in the construction of a bridge, and (2) in its failure to properly inspect the same after a washout, and thereby discover its unsafe condition. It was shown that a portion of the bridge was washed away by a rainstorm; that the section foreman and men on whom devolved the duty of inspecting it, though provided with appliances and means with which to have discovered the washout and prevented the accident, did not do so, and took no precautionary measures, and that the conductor was ordered to run the train over the bridge. Under these circumstances a person injured could recover for the company's negligence in failing to discover the washout, regardless of the negligent construction of the bridge. (St. L. & S. F. Ry. Co., v. George. Supr. Ct. Tex., 19 S. W. Rep., 1036.)

Appropriation and Abandonment of Water.

Certain persons appropriated, by means of the B ditch, the water remaining in a stream after two prior appropriations. The supply proving insufficient after several years, they each purchased a certain number of shares in the T. ditch and the water appropriated by it, and diverted the same to the B. ditch. After a time other shareholders in the T. ditch also, by permission, diverted their water through the B. ditch, and, finally, the T. ditch was abandoned, and all the water taken through the B. ditch. Thereafter for many years the entire amount of water taken through the B. ditch was distributed in proportion to the ownership of shares in the T. ditch appropriation, without regard to the original appropriation, by means of the B. ditch. This constituted an abandonment by the original appropriators, and their successors of their claim to the water originally taken by the B. ditch. (Hewitt, v. Story. U. S. Circ. Ct., S. D. Cal., 51 Fed. Rep., 101.)

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXIII.

(These articles will be republished in book form, and corrections or proper additions are solicited, and can be made at any time.)

DISTRIBUTION OF TIME.

The distribution of the time devoted to the various studies of the course can be considered in two ways:

1. In reference to the relation of the time devoted to (1) recitations or lectures, (2) laboratory or drawing room work and (3) field or shop work.

2. In reference to the total amount of time devoted to the several studies or classes of studies.

We will consider both of them, beginning with the first.

At the very outset we are met by a serious difficulty which cannot be wholly eliminated, and which consequently renders all fair comparison between crowd into every week as much work as can properly be done within the average student's limit of elasticity, and the amount of work done by the students per week will not be materially different whether there be 36, 38 or 40 weeks per year, which limits define the usual range (see Tables XX., XXI.) And when the year is cut down to 32 or 33 weeks as it is at a few colleges, it is quite certain that the amount of college work done must be cut down nearly if not quite in proportion. Often this curtailment is made with very proper motives, as to afford the student more time for vacation work or experience, but it certainly abbreviates by so much the amount of college work proper which is done in each year.

With one or two exceptions (of which the University of Virginia is one), all the colleges regard the week as having five working days only, but whether it be made five or six is obviously a matter of indifference in regard to the total amount of work work is taken as the equivalent of an hour of recitation or lectures.

With many different colleges making out independent returns as to the "Number of hours in entire course" devoted to each study in lecture room, laboratory or drafting room and field or shop separately, as they were asked to do in the forms sent out by us and from which we derive our information, it is natural that some startling irregularities should appear in respect to the reported "number of hours in entire course" due to the different classes of "hours" which we have noted. Some returns proved to be based upon one kind of hour; some on another. Some adopt one kind of hour systematically, carrying through the proper equations in the three subclasses of work specified and shown in Table XXII.; some (apparently) do not, but report laboratory or shop hours in full, and lecture room hours at their face value only, so as to indicate incorrectly the proportion of time given to each.

TABLE XXII.

GIVING REPORTED TOTAL NUMBER OF HOURS OF WORK AT EACH COLLEGE AND ITS EQUIVALENT IN REPORTED NUMBER OF HOURS PER WEEK.

	Reported Number of Hours in Entire Course.										
	Civil Engineering.				Mechanical Engineering.				Total weeks in course.	Reported No. hrs. per week.	
College.	Recit. and lect.	Lab. and dr. rm.	Field and shop.	Total hrs.	Recit. and lect.	Lab. and dr. rm.	Field and shop.	Total hrs.		C. E.	M. E.
1. Rens	707	484	....	1,191	....	....	....	....	160	7.5	....
2. Harv.	2,408	1,556	701	4,665	....	....	....	....	152	30.7	....
3. Yale	1,409	450	220	2,079	1,330	973	87	2,210	114	18.3	19.4
4. Dartm		No report.			....	....	....	....	132	....	....
5 Union	2,771	1,002	40	3,813	....	....	....	....	152	35.1	....
6. U. Mich.	1,845	522	180	2,547	1,523	774	540	2,837	144	17.7	19.7
7. P. Inst., Br.		No report.			....	....	....	....	160	..	....
8. Pa. M. Ac.	1,600	993	225	2,818	....	....	....	....	140	20.1	....
9. Columb.	1,657	1,844	700	4,201	....	....	....	....	128	32.9	....
10. W. & Lee.	1,962	450	100	2,512	....	....	....	....	156	16.1	....
11. M. I. T.	2,241	822	225	3,288	....	....	....	....	136	24.2	....
....	....	....	....	....	1,560	1,083	418	3,061	131	....	23.2
12. Lehigh	2,140	171	100	2,411	1,816	427	171	2,414	152	15.8	15.8
13. U. Va.	1,800	940	180	2,920	....	....	....	....	117	24.9	....
14. Cornell U.	2,298	1,635	820	4,753	....	....	....	....	160	29.7	....
15. Tufts	1,634	860	305	2,799	1,419	1,458	120	2,997	114	24.6	26.3
16. U. Ga.	1,845	445	95	2,385	....	....	....	....	144	16.6	....
17. Lafa		No report.			....	....	....	....	148	....	....
18. Wash. U.	2,910	1,520	1,000	5,230	2,570	1,500	760	4,830	200	26.1	24.2
19. U. Vt	1,660	630	350	2,640	....	....	....	....	152	17.4	....
20. Kans. A. C.	1,722	256	100	2,078	....	....	....	....	160	13.0	....
21. Worc. P. I.	1,869	1,140	656	3,665	1,550	642	2,000	4,192	133	27.5	31.5
22. Ala. P. I.	1,735	375	245	2,355	....	....	....	....	152	15.5	....
23. Me. Agr. C.	3,390	824	335	4,549	....	....	....	....	144	31.6	....
24. Ia. Agr. C.	2,190	1,045	208	3,443	....	....	....	....	132	26.1	....
25. U. Pa.	3,500	1,400	240	5,140	3,440	890	720	5,040	161	32.1	31.5
26. Stevens					2,155	1,593	451	4,199	160	....	26.3
27. U. Wis.	2,164	1,378	316	3,858	2,123	2,200	900	5,223	148	26.1	35.3
28. Thayer (D.)		Post graduate.			....	....	....	....	66	....	....
29. Swarthm.	3,452	1,818	765	6,035	....	....	....	....	148	40.8	....
30 Cornell U.	....	....	....	....	1,170	1,630	100	2,900	160	....	18.1
31 U. Mo.		No report.			....	....	....	....	108	....	....
32. U. Cal.	2,376	2,014	222	4,612	2,080	1,944	444	4,431	146	31.5	30.3
33. U. Kans.	1,753	965	311	3,029	1,163	1,155	660	2,978	132	22.9	22.5
34. U. Minn.	1,408	1,802	442	3,632	1,193	1,726	740	3,659	148	24.7	24.8
35. Rutgers		No report.			....	....	....	....	144	....	....
36. U. Iowa.		No report.			....	....	....	....	152	....	....
37. Corn. C., Ia.	5,902	920	685	7,507	....	....	....	....	144	52.3	....
Do. class hours.	1,127	920	685	2,732	....	....	....	....	144	19.0	....
38. U. Ill.	2,339	841	142	3,322	2,054	613	200	2,867	144	23.1	19.9
39. U. Cinc.		No report.			....	....	....	....	136	....	....
40. Princeton		No report.			....	....	....	....	140	....	....
41. Tex. Agr. C.	1,840	1,480	180	3,500	2 094	1,705	36	3,835	156	22.4	24.6
42. U. Neb.	2,057	1,276	....	3,333	....	....	....	....	142	23.5	....
43. Colo. Sc. M.		Mining course only, imperfectly reported.							152	....	....
44. W. U. Pa.		No report.			....	....	....	....	148	....	....
45. State C., Pa.		No report.			....	....	....	....	152	....	....
46. Purdue	945	1,158	....	2 103	....	....	....	....	152	13.8	....
47. Rose P. I.	4,654	2,432	594	7,680	....	....	....	....	148	51.9	....
48. U. Tex.	1,747	1,200	....	2,947	....	....	....	....	140	21.1	....
49. Mich. M. M.		(Mining course.)			1,484	2,006	1,120	4,610	135	....	34.1
50. Mich. Ag. C.	....	....	....	....	1,975	435	....	2,410	144	....	16.7
51. U. Ga.	....	....	....	....	2,223	982	2,150	5,355	144	....	37.2
52. Mont. Sc. M.		(Mining course)			2,847	2,430	460	5,737	160	....	35.9
Haverford		....	....	....	1,500	1,100	....	2,600	148	....	17.5
Un. No. Ca.	1,382	851	56	2,289	....	....	....	....	148	15.5	....

NOTE.—The figures in Tables XXII. and XXIII. for individual colleges MAY NOT BE FAIRLY COMPARABLE except when about the same number of total hours of work per week are reported by the colleges in question, as explained in the text.

TABLE XXIII.

APPARENT NUMBER OF WEEKS IN ENTIRE COURSE DEVOTED TO RECITATION WORK, DRAWING AND LABORATORY WORK, AND FIELD AND SHOP WORK; ALSO THE APPARENT PERCENTAGE OF TIME DEVOTED TO EACH.

	Civil Engineering.				Mechanical Eng.				Percentages. Civ. Eng.			Mech. Eng.		
	Recit. and lect.	Lab. and dr. rm.	Field and shop.	Total weeks.	Recit. and lect.	Lab. and dr. rm.	Field and shop.	Total weeks.	Recit. and lect.	Lab. and dr. rm.	Field and shop.	Recit. and lec.	Lab. and dr. rm.	Field and shop.
1 Rens	95	65	..	160	..	..	..	..	59	41	..	..	..	..
2. Harv	78	51	23	152	..	..	..	..	52	33	15	..	..	..
3. Yale	77	25	12	114	69	49	5	68	22	10	60	36	4	
4. Dartm	No report.			132	..	..	..	..	..	..	..	..	..	..
5. Union	109	40	3	152	..	..	..	..	72	26	2	..	..	..
6 U. Mich.	102	30	12	144	78	39	27	71	21	8	54	27	19	
7. P. I., Brkl.	No report.			160	..	..	..	..	..	..	..	..	..	..
8 Pa. M. Ac.	77	48	15	140	..	..	..	..	55	34	8	..	..	..
9. Columb.	51	56	21	128	..	..	..	..	40	44	16	..	..	..
10. W. and Lee.	121	28	7	156	..	..	..	..	72	18	3	..	..	..
11. M. I. T.	91	32	13	136	..	..	..	..	66	24	10	..	..	..
....	....	....	....	132	67	47	18	..	..	..	..	51	35	14
12. Lehigh	134	11	7	152	113	27	12	89	7	4	74	18	8	
13. U. Va.	68	37	12	117	..	..	..	..	59	31	10	..	..	..
14 Cornell	77	55	28	160	(See No. 30)			49	34	17	..	..	..	
15. Tufts	67	35	12	114	53	54	7	58	31	11	47	47	6	
16. U. Ga.	112	27	5	144	..	..	..	..	77	19	4	..	..	..
17. Lafa'te	No report.			148	..	..	..	..	..	..	..	..	..	..
18. Wash. U.	107	57	36	200	106	62	32	54	28	18	53	31	16	
19. U. Vt.	95	37	20	152	..	..	..	..	63	24	13	..	..	..
20 Kans. A. C.	132	20	8	160	..	..	..	..	83	12	5	..	..	..
21. Worc. P. I.	68	41	24	133	49	20	64	51	31	18	37	15	48	
22. Ala. P. I	112	24	16	152	..	..	..	..	74	16	10	..	..	..
23. Me. Agr. C.	100	25	19	144	..	..	..	..	70	17	13	..	..	..
24. Ia. Agr. C	84	40	8	132	..	..	..	..	64	30	6	..	..	..
25. U. Pa.	109	44	7	160	109	28	23	68	27	5	68	18	14	
26. Stevens	..	..	..	160	76	54	30	..	..	..	47	34	19	
27. U. Wis.	79	49	20	148	59	62	27	53	33	14	40	42	18	
28. Thayer (D.)	Post graduate.			66	..	..	..	..	..	..	..	..	..	..
29. Swarthm.	85	45	18	148	..	..	..	57	30	13	..	..	..	
30. Cornell	(See No. 14)			160	65	88	7	..	..	..	41	55	4	
31. U. Mo.	No report.			108	..	..	..	..	..	..	..	..	..	..
32. U. Cal	75	64	7	146	68	63	15	51	44	5	47	43	10	
33. U. Kans.	76	42	14	132	52	51	29	58	32	10	39	39	22	
34. U. Minn.	57	73	18	148	48	70	30	39	49	12	33	47	20	
35. Rutgers	No report.			144	..	..	..	..	..	..	..	..	..	..
36. U. Ia.	No report.			152	..	..	..	..	..	..	..	..	..	..
37. Corn. C., Ia.	113	18	13	144	..	..	..	79	12	9	..	..	..	
Do. class hrs. only	69	48	36	144	..	..	..	41	34	25	..	..	..	
38. U. Ill.	78	56	10	144	90	41	13	54	39	7	63	28	9	
39. U. Cinc.	No report.			136	..	..	..	..	..	..	..	..	..	..
40. Princet	No report.			140	..	..	..	..	..	..	..	..	..	..
41. Tex. Agr. C.	80	64	12	156	84	70	2	51	41	8	54	45	1	
42. U. Neb.	88	54	..	142	..	..	..	62	38	..	..	..	..	
43. Colo. Sc M.	No report.			152	..	..	..	..	..	..	..	..	..	..
44. W. U. Pa	No report.			148	..	..	..	..	..	..	..	..	..	..
45. State C., Pa.	No report.			152	..	..	..	..	..	..	..	..	..	..
46. Purdue	68	84	..	152	..	..	..	45	55	..	..	..	..	
47. Rose P. I.	89	47	12	148	..	..	..	60	32	8	..	..	..	
48. U. Tex	83	57	..	140	..	..	..	59	41	..	..	..	..	
49. Mich. M. M.	(Mining course)			135	43	59	33	..	..	..	32	43	25	
50. Mich. A. C.	..	..	..	144	117	27	..	..	..	..	81	19	..	
51. U. Ga.	..	..	..	144	60	26	58	..	..	..	42	18	40	
52 Mont. S. M.	(Mining course)			160	80	67	13	..	..	..	50	42	8	
Haverford	..	..	..	148	85	63	..	..	..	..	58	42	..	
U. No. Ca.	89	55	4	148	..	..	..	60	37	3	..	..	..	

NOTE.—The figures in Tables XXII. and XXIII for individual colleges MAY NOT BE FAIRLY COMPARABLE except when about the same number of total hours of work per week are reported by the colleges in question, as explained in the text.

the figures for particular colleges to follow a doubtful and dubious matter. The mere face of the returns may do any one college more or less than justice. The average will be less doubtful, but even that may not give absolutely fair indications.

In the first place, what is a fair measure of the total amount of work done in a course? Certainly not the number of years, because one or two colleges with only a three-year-course have more working weeks in their course than one or two others which extend it over four years. As certainly the number of weeks in the course is not an absolutely fair measure, because colleges with only a 32 or 33-week year will certainly aim to crowd a little more work into each week than colleges having a 45-week year.

But in the main the aim of every college is to done, if the aim be in each case to do as much as each student can properly do week after week, as must be assumed, and is doubtless the case.

The number of hours in each day or each week or the entire course is plainly a still more delusive and uncertain unit of comparison. What is an "hour"? In the lecture-room it means one thing, and requires one to three hours of previous or subsequent independent labor by the student. In the laboratory, drawing room, shop or field, it means another and quite a different thing; it then requires no previous or subsequent work. For this reason a custom has grown up at many of our leading colleges of "equating" the two classes of hours. A lecture room hour is taken as a unit, and 3 hours of shop or field work or 2½ hours of laboratory

For example, the Rensselaer Polytechnic Institute returns only 1,191 hours of formal work for its entire course of 160 weeks. The Rose Polytechnic Institute with only 148 weeks in its course, reports 7,680 hours in its course, and Cornell College, Iowa, with 144 weeks, reports 7,507 hours! The latter college, however, makes a double return for the two classes of hours, as shown in Table XXII., showing that it considers one of its lecture-room hours equal to almost five hours in all of student work. We trust it is, but as their returns imply 52 hours per week of actual work, we feel some doubts.

Even supposing all ambiguity to be removed as to what an "hour" meant in each return, there is still another impediment to reducing all to some common and uniform basis, so that comparisons may be ap-

proximately fair. Supposing 1,000 hours in all of actual student work to be devoted to some study, it is obvious that it makes little difference in the result whether 50, 100, 200, or 500 of those hours have been absorbed in formal class room work or lectures. Some educators prefer one system, some another. Some leave the student almost wholly free to work as pleases himself except for occasional examinations; some adopt the contrary system of requiring very little private work; and each system will give good results in good hands and bad results in bad ones. It is obvious, therefore, that the number of class-room hours, even if accurately reported in each case, would not mean quite the same thing in any two cases.

The usual practice of the college, so far as we can determine it, is to require from 15 to 20 hours per week of class-room work, or its equated equivalent in laboratory, field or shop work. In most of the returns, morover, it was plain that some effort had been made to equate the number of hours reported, so that an "hour" should mean about the same amount of student work, whether in the class-room or in the shop or field. In a few cases where the internal evidence seemed to make it clear that this equation had been neglected we have made it, and in a large number of cases where all the time on "surveying," for instance, was carelessly placed under the "Recitation or lecture room" column we have placed a part of the time under the columns for drafting room or field practice, according to inherent probabilities, leaning always to the conservative side, i. e., never making the change greater than was certainly demanded.

Except for the latter corrections only the first seven columns of Table XXII. represent the face of the returns of "hours in entire course." All are exactly as returned by the several professors, except for some transfers from one column to another as just explained, and excepting the returns for Yale, Lehigh and University of Pennsylvania. That for Yale was prepared for us by a graduate of the Sheffield Scientific School; these for Lehigh and University of Pennsylvania we have compiled for ourselves from their catalogue schedules which are quite complete. Perhaps for this reason Lehigh shows an exceptionally small proportion of laboratory, drafting room, field and shop work, but the error, if any, is chargeable only to lack of explicitness in the published schedule.

The next column of the table shows the actual number of weeks in the entire course, which we take as the best feasible measure of the relative amount of student work in the course, as already explained. This number of weeks, divided into the reported "total hours of course" gives the number of hours per week assumed in the report of each college, as given in the next and last column of the table. It will be seen to vary very considerably, between the extreme limits of 7.5 and 52.3 hours per week, but most of the returns fall within the limits of 15 to 25 hours per week. More precisely, the alleged number of hours per week varies as follows:

Colleges of Civil Engineering.	Hours.	Nominal hours per week.
1 college (Rens. Pol. Inst.*), reports a mean total of		7.5
2 colleges report between	10 and 15, averaging	13.4
9 " " "	15 and 20, "	16.9
10 " " "	20 and 25, "	23.1
5 " " "	25 and 30, "	32.3
6 " " "	30 and 35, "	32.3
2 " " "	41 and 52, "	46.3
Total number of colleges of civil engineering reporting distribution of students' time in detail		35

We are unable to explain the exceedingly low number of "hours" reported by Rensselaer, which is much lower than any other in the list. The report seems to have been carefully made out and is accompanied by the following: "Note. The total number of hours in entire course is taken to mean the total number of hours for each student and is so given. Of course the total number of hours the instructors are employed is two or three times this, ranging with the number of sections into which the class is divided."

Colleges of Mechanical Engineering.	Hours.	Nominal hours per week.
7 colleges report between	15 and 20, averaging	18.1
5 " " "	20 and 25, "	23.9
1 " " "	25 and 30, "	25.3
4 " " "	30 and 35, "	31.9
3 " " "	35 and 37, "	36.1

The mining courses we have not considered at all in this part of our investigations when the college had any other engineering course, as separate courses in mining engineering seem to be going out of date, and the mining course is apt to be cast on about the same lines as the other courses, when there are any other. In two cases where there was only a mining course to report, however, we have placed it in the same column as the mechanical, in Tables XXII. and XXIII.

It will be obvious that, having from Table XXII. the number of hours which constitutes a week's work for the separate colleges, by dividing the number of hours allotted in the returns to the several studies and classes of studies, we can determine with some accuracy about how many weeks of each college course are devoted to each subject, and thus have some approach to a fair common measure.

With much less confidence we present in Table XXIII. a summary of the relative number of weeks devoted at each college to class work, laboratory work and field or shop work. To guard against unfounded deductions in comparisons of one college with another we call particular attention to the double return for Cornell College, Iowa, in Tables XXII. and XXIII., showing the material difference in the apparent proportion of time devoted to laboratory or shop work which results from including or excluding study hours from class-room hours.

With the study hours not counted, it would appear as if only 41% of the student's time was devoted to class work; 34% to laboratory or drafting room work, and 25% to field or shop work. With the study hours counted as part of the "recitation" work these percentages become 79%, 12% and 9% respectively. The last gives by far the fairer idea of the actual distribution of the student's time.

This, however, is an extreme case, as will be seen by referring to Table XXIII. It is probable that the study hours, being mere guess-work anyway, were somewhat exaggerated in the Cornell College return, as both were given. A mean between the two returns would probably give about a fair idea of the distribution of the student's time, and most of the colleges' figures fall close to such a mean and very far from the two extremes of the Cornell College (N. B., not Cornell University) double returns.

We believe therefore, that between any two colleges reporting about the same number of hours per week of student's work the ratios given in Table XXIII. will be fairly comparative. Even when the reported number of hours per week is quite different they may be fairly comparative, and in most cases are so; but in this latter case there is room for doubts which we cannot remove, and, therefore, we leave this table to speak for itself without attempting to discuss its bearing upon this feature of the work of the separate individual colleges.

THE WESTERN UNIVERSITY OF PENNSYLVANIA.

Sir: In Engineering News of Sept. 8, Table XX., under "degrees conferred," and opposite Western University of Pa., you place Ph. B. This is not correct, since in the engineering schools the university grants the degrees of C. E., M. E. and E. E. The degree of Ph. B. is conferred on students who have successfully completed the scientific course in the department of literature, science and arts. Moreover, our scholastic year contains 40 weeks, the same as the R. P. I., but making a very close count, closer, perhaps, than has been done in the institution named, and some others, you will perceive that there are at least 38 weeks of actual work per annum, making a total of 152.

Again, to entitle the student to admission to the senior class, each junior is required to visit during his summer vacation some bridge or other engineering structure, and produce a description of the same, accompanied by a line drawing of the whole, and detail drawings of the essential parts; credit should be given for this under the proper head.

Under "cuts," the word "variable" should be written opposite W. U. P.

I send this information not because it is a matter of very great moment to us, but because you have repeatedly stated that you desire the account which you are giving of the engineering schools of the United States to be as correct as possible.

Respectfully yours,
Dan'l Carhart.

The Sewerage Commission of San Francisco has met with an obstacle in the refusal of the City Auditor to approve the expenditures necessary for the Commission's work. That official takes the ground that the Commission was appointed without legal authority, and that no warrant in law exists for the expenditure it will cause.

SOME RAILWAY "IMPROVEMENTS" OF 60 YEARS AGO.

In the late competitive tests, in Boston of fenders for electric street cars, one of the difficulties met with by the inventors was, that while their devices would generally safely dispose of a prostrate figure on the track they failed when encountering an erect figure or one moving across the track. In this connection it is interesting to note that a demand for some similar fender was brought out by the first fatal railway accident on record, the one resulting in the death of Mr. Huskisson at the opening of the Manchester & Liverpool Railway, in 1830.

To prevent similar accidents Sir George Cayley suggested "some improvements in railway carriages" and published his views in "The Mechanics' Magazine," of May 7, 1831, and from this publication the following cuts and their explanations are taken: It may be said at the beginning that Sir George met the difficulty confronting the Boston inventors, by first knocking down his man and then scraping him up, as is graphically shown in his cut, Fig. 1. He proposed a hinged and padded frame "D," with two or more projecting curved feelers terminating in pads. The operation of knocking down the man was to release a catch "E" and drop the frame "D," and the point of this frame was then "to commence ploughing up the road for, say, two inches deep over the whole width of the carriage path and gradually to stop the vehicle by the increased friction and resistance it creates." By this somewhat unique method of stopping the train the man was to be gently scooped up by the padded frame and held for further disposal.

Fig. 1.

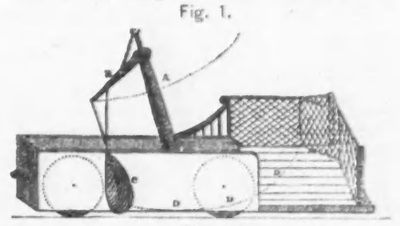


Fig. 2.

Sir George Cayley's Proposed Fender and Landing Scoop for Railway Trains.

Sir George, in the same article, further says that "the expense of railways must ever cause them to be few in number," and he thought it clear that this cause would also confine their use chiefly to the conveyance of passengers. This being so, to obviate the unpleasant necessity of having to stop "at every point where the traveler may strike the railway" Sir George was further satisfied that "the problem will sooner or later arise of furnishing some means of getting passengers on board without materially altering the velocity of the train." He excepts females and aged persons and luggage in the plan he proposes in Fig. 2.

In describing the plan "which occurs to me as the most likely to become practicable when improved by experience," he goes on as follows: "Let an inclined mast stand on the platform of the hindermost carriage 'A,' on the top of which is a gudgeon, on which turns an arm 'B' supported by a chain-stay from the top of the gudgeon. From the further end of this arm let any convenient form of rope or net-work hang down within a few inches of the ground as at 'C.' I conceive that any active person, by standing in the path of this net may stay its advance for an instant until secure in his hold, when without further effort he will, by his own 'vis inertia,' and the progress of the car be lifted in a curve 'D D' onto a rising platform behind the car, guarded by a strong netting and well padded uprights, so as to prevent injury." A catch is to prevent the arm from swinging back until liberated for use.

Sir George suggests several other equally valuable "improvements" for these two purposes that it is not necessary to go into here; but he also crudely

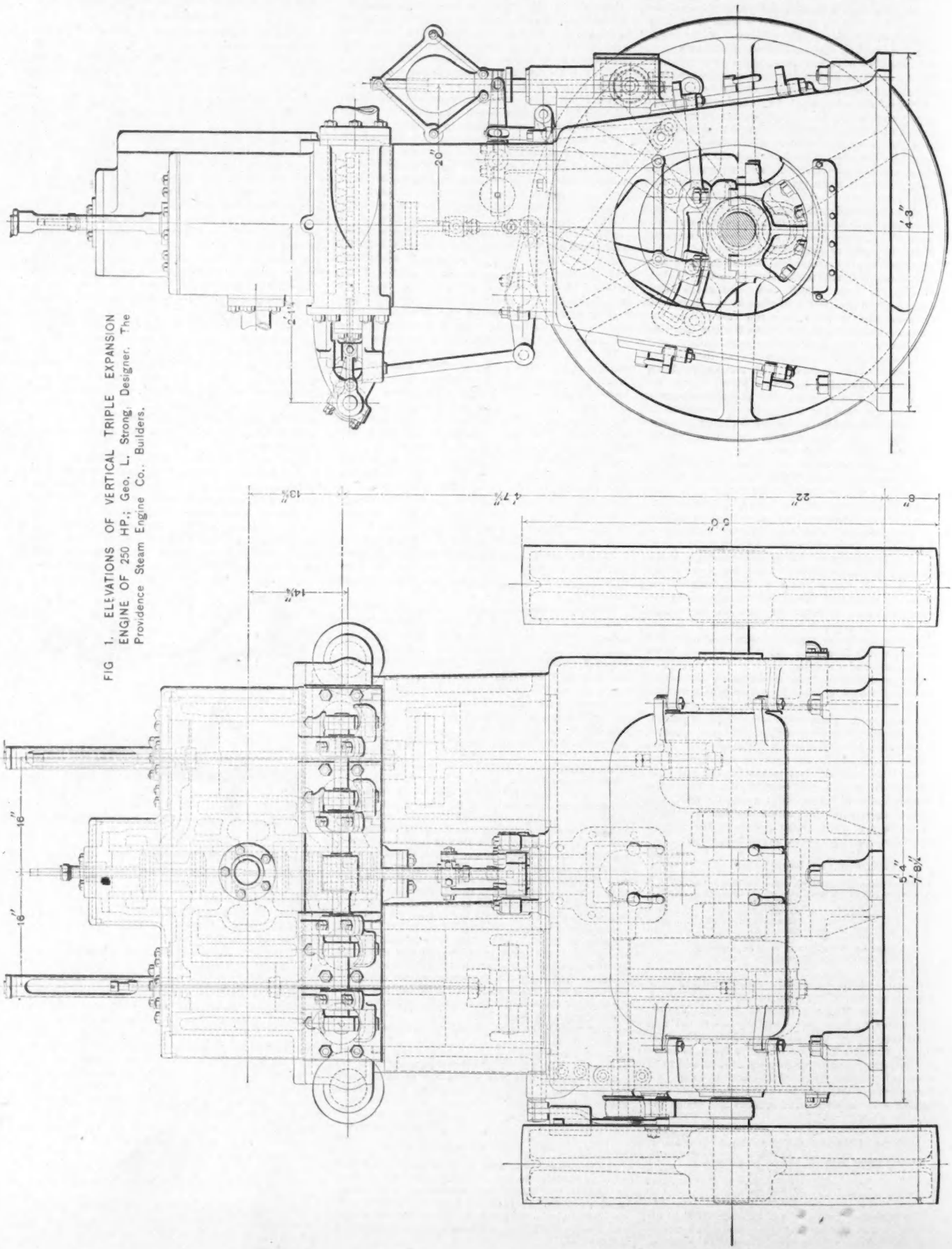


FIG 1. ELEVATIONS OF VERTICAL TRIPLE EXPANSION ENGINE OF 250 HP.; Geo. L. Strong, Designer. The Providence Steam Engine Co., Builders.

anticipates several devices now in common use. Thus he suggests the modern locomotive pilot, or cow-catcher, when he proposes to make the frame 'D,' in his first scheme, with a point in front and with sloping sides, so as "to cast the obstacle out of the path of the carriage." His buffer plan, crude as it is, was intended to meet a difficulty that is now before modern inventors, and his "scoop" contains all the essential features of the "mail-bag catcher" of the present day. He was wise, however, in specifying that his passenger-landing device was intended only for "men of activity," and that "perhaps, for females and aged persons, and when luggage was to be taken up, stopping stations at convenient intervals, will ever remain the best plan."

THE EXTENDED USE OF THE HYDRAULIC RAM.

At the late meeting of the British Association, at Edinburgh, Mr. W. D. Pearsall, of London, read a paper on the above subject. The President of Section G., Professor Unwin, the eminent hydraulic engineer, fully indorsed the claims made for the usefulness of these engines and said that Mr. Pearsall had raised the hydraulic ram from the position of a merely domestic motor to that of important engineering plant. In our issue of Sept. 28, 1889, we illustrated and described this machine in detail, but we here give an abstract of the later paper as follows:

The hydraulic ram is a machine of extreme simplicity which enables the power of a fall of water to be used directly to raise water to any desired height, and it is the only known means of doing this directly; all other means being more or less roundabout and complicated, being a combination of at least two machines, involving a double transformation of power. This simple machine has, therefore, many very great advantages over any alternative methods, but notwithstanding this we find that 100 years after its invention the older methods are still in use. The author investigates the reason of this and shows that it is chiefly due to an imperfect realization of the principle of the machine. The paper gives an account of an investigation into this subject by the author and the results arrived at.

The ordinary hydraulic ram as designed by Montgolfier, and as still made, is then described. The violence which accompanies the action of these machines is the first and obvious reason against their application to large quantities of water. This has given currency to the idea which the author found to be prevalent that, as commonly stated, such machines "acted by a blow."

This is shown to be a mistake by reference to the elementary dynamic law that any body in motion can be stopped by any resistance however small, if it continues to act through sufficient distance; from which it follows that the proper action is not "by a blow" but by a continuous motion of the water against a steady resistance. The actual causes of the violence which is admitted to occur are then shown to be partly internal, due to avoidable errors in construction and partly and principally to the concussion of the waste valve in closing at a high speed.

The author then mentions the attempt made by various inventors to diminish this violence by cushioning the blow of the valve which, while partially successful in their immediate object, result at the same time in impairing the efficiency of the machine, and shows that the explanation sometimes given of this result, viz., that it prevents the instantaneous action imagined to be necessary, is untenable. The true reason of the observed effect is shown to be merely that the slowness of shutting produced by cushioned chokes the flow and, this being so, a method is at once suggested of shutting slowly without choking the flow, and consequently without impairing the efficiency of the machine.

It having been thus shown that all existing causes of violence are removable it does not appear that there is any other reason to prevent the extended use of this principle, and, in some respects, it is much more suitable for use on a large scale than on a small, notably on account of the smaller coefficient of friction in large pipes.

A large engine was constructed to prove the above ideas in practice and discover any unforeseen practical difficulties. The proportions of this engine were entirely deduced from theoretical consideration, discarding the empirical rules formerly in use, as it was found that the theory of the machine indicated the advantage of proportions differing from these. It was also evident that the periods of time during which the main valve was open and shut would be of great importance and the most suitable times were therefore determined and machinery designed to give the valve exactly this motion. It also became evident that a very much higher velocity might be used in the flow pipe than had hitherto been used, with the effect of greatly increasing the power of a machine of given size.

The first engine made on this basis was successful, and three others have since been made differing in some practical details. The principal features of these engines are the use of an annular slide valve for the waste valve moved by a cam, in order to obtain exactly the motion required and bring the valve to its seat without any impact, the gradual shutting of this valve being prevented from checking the momentum of the water by the provision of a space into which some of the water flows during the shutting of the valve. This space or ante-chamber, is emptied of water during the opening of the main valve, being provided with an air valve which admits air at that time, and allows the air to escape as the chamber fills with water.

Precisely similar engines have also been used to compress air, the air being compressed in a chamber similar to the ante-chamber spoken of above, and its quantity being capable of exact regulation by placing the air valve in a tube the depth of which below the roof of the chamber is regulated by a screw.

The general results obtained from these engines are: 1. Entire absence of violence as predicted, as shown by indicator diagrams.

2. Very high efficiency, amounting to over 70% when pumping water and over 80% when compressing air.

3. That the construction is simple and much less costly than the ancient method and the management of the engines is easy and the wear slight.

4. Evidence that a similar construction is equally feasible for engines having flow pipes 3 ft. or 4 ft. in diameter.

In short, it has been established as a fact of actual experience that the simple and useful principle of the hydraulic ram may safely and very advantageously be extended to nearly all cases where water power is used for pumping or for compressing air, and that there is no need at all to continue in future the use of the antiquated indirect methods, and very strong reasons for not doing so.

The author further mentions the result of recent experience in using still higher velocities in the flow pipe with a view to still further increasing the power of engines of a given size. Velocities eight times as great as used in ordinary rams have been already employed and the author expects to employ even greater velocities in future.

The great aid supplied by these machines to the problem of transmission of power is then pointed out. The incidental advantages of using compressed air for this purpose are great, but the practical objection hitherto has been the loss of power incurred in compressing air. As this loss is by the use of the above method almost entirely eliminated, this method of transmitting power will, it is believed, compare favorably with any known method. The reason for the very great efficiency obtained in compressing air (besides simplicity of the apparatus) is that it is accomplished with hardly any heating because the air during compression (1) is surrounded by and is in contact with cold water in very large quantities; (2) is compressed in a chamber which is washed inside and out at every stroke by large quantities of cold water and (3) metal surfaces, similarly cooled, can be added in the midst of the air to any desired extent.

HOPPER DREDGE FOR CEYLON.

A large hopper dredge, called the "Triton," is being built in England for the Colombo harbor works, in Ceylon. It will be 176 ft. 6 in. long on the deck line, 172 ft. long between perpendiculars, 30 ft. molded beam and 13 ft. deep; the mean draft will be 10 ft. 9 in. loaded, and 17 ft. 6 in. empty. The aggregate capacity of the hopper compartments will be 500 tons of dredgings at 20 cu. ft. per ton, and there will be the necessary gear for lifting and lowering the hopper doors. The vessel is to be adapted for loading barges on either side when required, in addition to filling its own hoppers. The buckets have a capacity of 12 cu. ft. each. The bucket ladder will work in a central well, and dredge to a depth of 36 ft. under water-level when light. The vessel will be propelled by one set of triple expansion engines driving a single screw, and the boilers are to be of suitable capacity to supply the engines with steam sufficient to drive the vessel at a speed of 8 knots when loaded in sea-going trim in ordinary fair weather and smooth water. The hull will be subdivided into seven water-tight compartments, and all bulkheads are to be carried up to the main deck. Suitable accommodations will be provided for the officers and crew. Powerful triple-barreled steam mooring winches are to be provided at bow and stern, each barrel working independently or conjointly as required. The shell plating to be of steel and the deck to be of teak, 3 ins. thick. The engines are to develop under ordinary working conditions, 500 IHP., and are to be capable of working up to 600 I.HP. There are two return, multitubular, boilers constructed of mild steel for a working pressure of 150 lbs. per sq. in. The diameter is 8 ft. 9 ins. and length 10 ft., with a heating surface of 600 sq. ft. After the trials the hopper compartments and the bucket well are to be fitted as holds to carry coals for the voyage to Ceylon.

STRONG'S VERTICAL TRIPLE-EXPANSION ENGINE.

We illustrate herewith a new vertical triple-expansion engine designed by Mr. Geo. S. Strong, M. Am. Soc. M. E., to meet the growing demand for a high-speed engine of large power, occupying small space and working with a high rate of economy. The endeavor has been made to put a triple-expansion engine into the simplest and most compact form, seeking at the same time high efficiency and economy. It may be used with or without a condenser as desired, the condenser and air-pump where used being independent, as is now the usual practice. The 250 HP. engine shown in Fig. 1 stands 10 ft. 6 ins. over all and occupies a floor space 7 ft. 8½ ins. × 4 ft. 3 ins. (about 33 sq. ft.).

The general design of the engine is as follows: The two cranks are set 180° apart. The reciprocating parts thus move in opposite directions at the same time and balance each other within the frame. Thus less foundation is required and the engine runs more quietly than with cranks set quartering. If it is desired to make the engine absolutely noiseless, it can be set upon a foundation insulated from the foundations of the building by a layer of cork; at the sides packing of some sort can be used which will prevent the carrying of vibration to the walls.

Referring to the front elevation in Fig. 1, over the left hand crank is placed the h. p. cylinder and one single-acting l. p. cylinder. Over the right hand crank is the other single-acting l. p. cylinder and the intermediate cylinder. A single piston rod is used on each side, its tail end extending through the top cylinder cover. Cross-heads and guide-bars are entirely dispensed with, the trunk pistons of the single-acting l. p. cylinders keeping the piston rods in a straight line.

As the engine is intended to use steam of 180 to 200 lbs. pressure, piston valves have been used to control the steam supply to the h. p. and intermediate cylinders and gridiron slide valves for the l. p. cylinders. In this manner the high pressure hot steam is controlled by frictionless valves. The matter of clearance in the h. p. and intermediate cylinders, according to Mr. Strong, is comparatively unimportant. In the l. p. cylinders, however, he considers small clearance very necessary for economy and effects it by the use of gridiron valves. The total number of expansions at ordinary cut-offs is 12 to 14, reaching to 16 with the shorter cut-offs.

Following through the steam distribution: the live steam is admitted to the h. p. cylinder by a central piston-valve located between two exhaust piston-valves and in the same valve chamber. This central admission valve travels independently of the other valves, and by it the admission and point of cut-off is regulated for both ends of the h. p. cylinder. The steam is exhausted from the h. p. cylinder by means of two piston valves, one on each side of the above mentioned valve, which admit steam to the intermediate cylinders through auxiliary ports. These valves also control the exhaust from the intermediate cylinder, permitting it to escape into a passage leading to the l. p. cylinders. The admission to and

release from the l. p. cylinders are governed by the gridiron valves above referred to.

All these valves except the central valve admitting steam to the h. p. cylinder have a constant travel and are actuated by a hollow piston rod driven from an eccentric. The cut-off valve is actuated by a solid rod passing through the hollow stem which works the other valves. The cut-off is regulated by a sensitive high-speed ball governor driven by a belt from the main shaft. A weighted arm (see end view, Fig. 1) is connected by link-work to the governor and the weight is supported by an idler pulley running on the governor belt. In case of breakage of the belt the weighted arm carries the governor to the top of its travel and cuts off the steam at the shortest point. The h. p. cut-off valve is actuated by a block sliding in a Fink link, so designed as to give an equal lap and lead and the same cut-off at the two ends of the cylinder. The other valves are driven by connection to a fixed point at one end of the link.

The fact that cross-heads are dispensed with makes possible great simplicity in the frame of the engine. A single casting forms the bed of the engine, extending up to the bottom of the l. p. cylinders. The castings for these two cylinders are duplicates of each other and are perfectly plain, the steam passages being in the cylinder head. Another casting forms the h. p. and intermediate cylinders, and its base forms heads for the l. p. cylinders and contains the proper steam passages.

The crank shaft is forged from a solid steel ingot, and the counter-weight is bolted on. The pedestals are bored, and turned on their bases to fit a bored seat in the bed-plate or frame of the engine, to which they are secured by bolts. The seats for these pedestals are bored by a single setting of a boring bar, and are consequently in perfect alinement.

The engine of which a perspective view is shown is designed to make 250 I. HP. at 225 revs. per minute. The engine shown in Fig. 1 is intended to develop 150 HP. at 300 revs per minute. The builders of this engine are the Providence Steam Engine Co., who build the well-known Greene automatic cut-off engine. It is the intention of the builders to manufacture these engines in sizes up to 2,500 HP., and to build them of the horizontal type as well as the vertical where desired. The details of the engine have been worked out under the supervision of Mr. F. W. Dean, M. Am. Soc. M. E., of Boston, Mass.

FIG. 2. PERSPECTIVE VIEW OF STRONG'S ENGINE, WITH DYNAMOS MOUNTED ON MAIN SHAFT.

RAILWAYS OF THE WORLD.

A German engineer, Mr. Ernst Kohl, publishes in the "Civilingenieur," the following notes collected from available railway statistics of the German Government, extending to the year 1889. Mr. Kohl explains that the total length of railways in the world was then 375,000 miles, and that the total mileage had increased 5.26% in the period 1887-89.

In Europe there was 1 mile of railway to each 27.5 sq. miles of territory, and 3.7 miles to every 10,000 inhabitants. In the United States the corresponding figures were 1 mile of railway to 19.3 sq. miles and 23.9 miles to each 10,000 inhabitants. (This figure is now about 26 miles per 10,000.—Ed.) In Great Britain there are 6.3 sq. miles and in Belgium 3.7 sq. miles of area to each mile of railway. The average cost of European railways is estimated at $280,000 per mile, and the total cost of all the railways in the world is figured at $32,115,000,000.

THE ANDERSON REVOLVING WATER PURIFIER AT WORCESTER, ENGLAND.

A 3,600,000-gallon (U. S.) water purifying plant of the Anderson type has recently been put in operation at Worcester, England, and is described in "The Engineer" for July 22, 1892, to which we are indebted for the following information regarding the plant. As the Anderson process has been very fully described in these columns * a detailed description of the plant at Worcester is not necessary, but its main features and some points of difference between it and the first plant put in use will be of interest. The first plant was at Antwerp and was described in a paper by the inventor of the process, Mr. Wm. Anderson, M. Inst. C. E., published by the Institute of Civil Engineers and in Engineering News, of Sept. 5, 1885. The Antwerp plant had a daily capacity of 2,590,000 U. S. gallons.

The Anderson process of purifying water, stated briefly, consists in bringing the water for three or four minutes into contact with iron, preferably cast iron borings or turnings, then aerating, settling and filtering it. The contact with iron is secured by passing the water through a revolving cylinder containing particles of iron, the cylinder having shelves or ledges so arranged as to continually shower the iron through the water. Ordinary sand beds are used for filtration. Illustrations of the revolving purifier were given in connection with the article on the Antwerp plant, already mentioned.

At Worcester there are three revolving cylinders, each 21 ft. long and 5 ft. in diameter. At Antwerp there were also three cylinders 5 ft. in diameter, but only 15 ft. long. The Worcester cylinders are of rolled steel and those at Antwerp are of wrought iron. The five steel plates in the length of the Worcester cylinders are ⅜ ins. thick and the ends were dished out of single plates 9-16 ins. thick.

Each cylinder revolves on hollow trunnions resting on pedestal bearings. A 12-in. inlet pipe at one end and outlet pipe at the other connects with each cylinder through stuffing boxes in the trunnions. The cylinders are driven by a vertical engine from the crank shaft of which shafting passes and is geared with a 33-in. toothed driving wheel by means of a sliding pinion, each driving wheel being on a worm shaft the worm of which meshes with a heavy cast iron ring gear surrounding the outlet end of the cylinder.

Before being put in operation each cylinder receives 4,480 lbs. of cast iron borings against 2,464 lbs. in the smaller cylinders at Antwerp, as reported in 1885. In other words the charge of iron at Worcester is about 82% greater while the nominal capacity of the plant is only 39% greater than at Antwerp. The reason for using this increased amount of iron is not stated, but may be due to local causes.

A current of air can be forced into the water just before it enters the cylinder and means are provided at the outlet end for the escape of an excess of air.

After leaving the cylinders the water is said to be charged with proto-salt of iron formed by the natural reaction of the water, iron and air. The water is therefore aerated by passing it over a weir, the height of which can be varied, then through a trough of wrought iron 4 ft. wide, 15 ins. deep and 233 ft. long, and finally over both sides of a cast iron through 32 ft. long, from which the water passes to settling tanks. In addition to the above, air can be forced into the water through a perforated false bottom 24 ft. long at the inlet end.

By aeration the iron proto-salt takes up oxygen and precipitates ferric oxide, or rust. Part of the precipitate is deposited on the bottom of the trough and much or all of the remainder by settling tanks, of which there are two permitting of three hours undisturbed turbid settlement.

After settlement the water passes to filter beds through pipes pivoted and supported on floats so as to draw from the surface only.

There are five filter beds of sand with a combined filtering area of 8,100 sq. ft. The standard rate of filtration in connection with the Anderson process is a downward movement of water of 6 ins. per hour or a delivery of 89½ U. S. gallons per sq. ft. per 24 hours. Owing to the small filtering area at Worcester and the fact that the day's supply is pumped in 14 hours the average rate of filtration is nearly double the Anderson standard, and when one of the beds is being cleaned it is still higher.

It is stated that during five weeks the Anderson plant had been in operation the purified Severn water had been bright and colorless while the dissolved organic matter had been reduced 75% on the average and 85% during a week of flood. The settling tanks and filter beds, it appears, were in use before the Anderson plant was put in. It is stated that before the revolving purifiers were added sand filtration alone removed at the most only one-third of the dissolved organic matter and seldom rendered the water bright and colorless. But it is not stated whether as much care was taken to secure good results with ordinary filtration as with the present plant.

The new plant at Worcester was put in for the town by Messrs. Easton & Anderson, under an arrangement with the Revolving Purifier Co., London. Including alterations, the plant at English prices cost about $24,300, or about $8,000 per million gallons filtered, but it must be remembered that the settling tanks were already built and also some if not all of the filter beds.

The Anderson process has been or is now being tried experimentally at Philadelphia, Boston and Poughkeepsie, being used at the latter place in connection with the large filter beds already built.

* Engineering News, Feb. 14, June 6 and Sept. 5 1885; Jan. 1, 1887, and April 25, 1891 (under Society Proceedings).

CORROSION OF LEAD PIPES BY ELECTRIC CURRENTS.

Some puzzling cases of lead pipe corrosion have recently been traced to the action of electric currents setting up an electrolytic action upon the pipe. In one case in the city of Saginaw, Mich., a lead pipe ran for some distance parallel to an electric railway and when taken up was found to be corroded completely away in spots, its appearance being very similar to that of a lead plate in a storage battery. An examination of the soil showed that it contained chlorides of magnesium and calcium, and it is known that chlorine is very destructive to lead battery plates. The "Electrical World" in a recent careful review of the case reached the conclusion that while the cause of the corrosion was not absolutely proved to be the electric current, the evidence pointed sharply in that direction. If a ground return was used, a shunt current would naturally pass through a neighboring parallel running lead water pipe, since it would be a far better conductor than the ground itself, unless the latter were very moist. As the current must pass from the ground to the pipe or vice versa, electrolytic action must take place on the outside of the pipe. It is not even essential that the pipe should run parallel to the track, for it might have run so as to act as a shunt to a loop, in which case the action would have been all the greater.

Another somewhat similar case of pipe corrosion is reported at Athens, Greece, in the "Electrotechnische Zeitschrift." The neutral wire of the central station at Athens was grounded by attaching it to a lead pipe about a mile long and 2 ins. in diameter. The lead covered cables at Athens are placed in wooden troughs coated with tar and resin and trouble was first experienced in the giving way of the lead covering of one of these cables, which showed a series of small pin holes resulting from a slow chemical disintegration of the lead sheathing.

Soon other accidents followed. Now there was a positive conductor at fault, now a negative one, and these troubles caused the company to employ greater care in the insulation of the entire installation. One thing became evident, that the grounding of the neutral wire had largely increased the chances of danger to the pipes from burning through, for it was found that strongly insulated conductors soon became faulty, and at last useless.

A short time ago the company was notified that the water pipe had become leaky. A careful investigation revealed the fact that the entire pipe showed a series of small holes; in fact, exactly the same signs of chemical disintegration were noticed which had been observed in examining the burned noticeable.

The walk on which the pipe is laid is at several points covered by water, continually flowing into the channel, and this water contains a small amount of oxygen. At these points the pipe was intact, but wherever it touched the damp masonry of the walk without being flooded by the running water, the pipe was perforated. At the points where the pipe touched the masonry the metal was badly oxidized and crumbled at the mere touch, and the chemical disintegration at the soldering points was especially noticable.

At first it was doubted that the trouble had been caused by electrolytic action, but when it was found that other lead pipes which were not attached to electrical conductors, but which had been placed in the same channel, showed no trace of damage, it was pretty well proved that the disintegration of the metal had been caused by the electrical current. The fact that the pipe was badly damaged at the points to which the conductors had been soldered, while wherever the pipe was surrounded by flowing water scarcely any damage could be detected, was another argument in favor of this view.

As a result of this experience the managers of the Athens company have concluded that grounding the neutral wire in three-wire systems is not to be recommended. It is argued in its favor that it permits the use of an uninsulated conductor for the neutral wire and decreases danger from short circuits. The managers believe, however, that it would be dangerous to build an entire system with an uninsulated neutral wire, and that the danger from short circuits is increased rather than decreased by grounding the neutral.

PERSONALS.

Mr. Henry M. Putney, of Manchester, N. H., has been appointed a member of the New Hampshire Railroad Commission.

Mr. Edward C. Shankland's official title has been changed from Engineer of Construction to Chief Engineer of the World's Columbian Exposition.

Mr. F. E. Prendergast, M. Am. Soc. C. E., has resigned the position of Agricultural Superintendent of the San Diego Land and Town Company.

Mr. Milo Davis, formerly Chief Engineer of the Iron Range & Huron Bay R. R., in Michigan, has been appointed consulting engineer for the same company.

Mr. Samuel G. De Coursey, President of the Western New York & Pennsylvania R. R., was struck and killed by a train on the Camden & Amboy R. R., at Beverly, N. J., on Sept. 17.

Mr. D. C. Dunlap's official title is Assistant Chief Engineer of the Chicago Sanitary District instead of Assistant Engineer, as stated in an article in our last issue and in another earlier article.

Mr. E. P. Reynolds, a well known railway contractor, who has done important work on the extensions of the Rock Island and other railways west of the Missouri River, died at Wymore, Neb., on Sept. 11.

Mr. Julian Kennedy, M. Am. Inst. Mining Engineers, has been appointed Chief Engineer of the Ohio Steel Co., and will superintend the erection of an extensive steel making plant at Youngstown, O. Mr. Kennedy was formerly at the Latrobe Steel Works.

Mr. James Kimber, M. Inst. C. E. and Engineer to the Corporation of Calcutta, has been recommended for knighthood by the Viceroy of India. Mr. Kimber has been engaged in engineering work in India for 33 years, and for 20 years has been the Engineer of Calcutta. He designed and built the present water supply systems of that city, and also its entire drainage system.

Mr. David Bruce, the inventor of the type-casting machine, died in Brooklyn, N. Y., on Sept. 13, at the age of 90. He was born in Scotland, but came with his parents to this country at an early age. His first patents on type casting machines were issued in 1838 and covered a hand-worked machine which produced 80 or 90 type per minute. The power driven machine soon followed.

Mr. Chas. A. Allen, who has for 15 years been City Engineer of Worcester, Mass., has resigned his position, the resignation to take effect Nov. 1. Some fault has been found by members of the City Council because Mr. Allen devoted a portion of his time to private practice. In reply, Mr. Allen stated that he could not afford to give up his outside work for the salary given by the city ($2,700 per annum) and he therefore tendered his resignation, which was accepted. During his term of service as City Engineer, Mr. Allen has constructed nearly the whole of Worcester's water supply and sewerage systems, including the sewage precipitation plant described in our issues of July 28, 1892, and Nov. 15, 1890. He is the engineer of the sewerage system and sewage purification plant at Westborough, Mass., now in progress, and has served as consulting engineer on many other important works in New England.

NEW PUBLICATIONS.

DER VERKEHR LONDONS (TRAFFIC OF LONDON). —Mit Besonderer Berucksichtigung Der Eisenbahnen. Gustav Kemmann, Kaiserlicher Regierungsrath. Julius Springer, Berlin. Folio; pp. 198; 6 large maps, 2 charts, numerous smaller engravings. $10.

In this elaborate and highly creditable volume the author gives a great mass of facts relating to all kinds of London traffic, but chiefly devotes himself to London's immense local railway traffic. He very ably and exhaustively discusses, however, the long distance traffic with the great manufacturing centers and seaports. The work has been compiled and published with true German thoroughness and neatness, and in respect of its exhibit of the possibilities of handling enormous traffic over a few lines, especially, is highly instructive, since nowhere else in the world are so many trains handled in a day past given points as in London.

Chapter I. treats in general on the traffic of Great Britain, showing how its favorable location, its numerous seaports, and its immense mineral resources, combined with the energy and skill of the Anglo-Saxon race, have given that country its great industrial lead over other European nations. Some general information is given on the values of exports and imports the total tonnage of incoming and outgoing vessels, and the passenger traffic to and from other countries, as also inland. The peculiar features of the English railway service, as seen from a German point of view, are illustrated. A brief, separate description of the English, Welsh and Scotch systems is given.

In Chapter II., the traffic of the city of London and its facilities are described and the increase of population, as shown by the decennial censuses tabulated. The limits of administrative territories, the industrial and commercial conditions of the city, the area of docks and the tonnage handled thereon, and the great markets of the city, are also briefly described. The section treating upon the principal branches of traffic contains some very good photographic reproductions of bridges and railway stations of London. A description of the diverging railway lines, with their network of connections, subdivided with a regard to passenger traffic into long-distance, suburban and inner city lines, follows. The large plates, 5 and 6, referring to this chapter, graphically represent by their different coloring and width of lines, the number of daily trains for passenger and freight service, respectively, the lines increasing in width as they converge toward the business center of the city. These maps are quite unique of their kind, and must have required great labor to compile. They are, perhaps, the most valuable single feature of the volume. The ownership, control and length of the railway lines is given in tabular form. A summary of passengers conveyed in 1887 by the different branches of city transit concludes this chapter.

Chapter III. treats of the regulation of rates for passengers and freight, the amalgamations and working agreements of the great systems, and the establishment of a clearing house for the determination of "running powers," etc. The partial supervision of railway lines by the Board of Trade and the working of the new law (Regulation of Railways, 1889), is also explained, under which the introduction of the block system and of interlocking signals and switches, the use of automatic brakes, and a type of safety coupling, to be determined upon by the Board of Trade, is made obligatory.

Chapter IV. relates to the several reports required, and while useful for reference, contains nothing of great novelty or interest. Toward the end of the chapter, however, the comparatively high cost of operating English railways, even from a German point of view, is commented upon; among the explanations suggested being the great speed and small tonnage of the freight trains; the many lightly loaded passenger trains; the legal and parliamentary charges; the continuous warring of competing lines, necessitating enormous counsel fees, and the tendency of English railways to do away with curves and grades as much as possible.

Chapter V. treats of operating practice, which is considered for local and long distance traffic separately. Quite full information as to the different types of rolling stock, arrangements of time-tables, etc., is given and supplemented by a number of maps and tables.

Chapter VI. treats of railway stations, arrangement of tracks, examination of tickets, general construction of tracks, signals, torpedo signals, and block signals. The absolute (either manual or automatic) and the permissive block system is briefly described. The signals in use at Mansion House station are described in a separate article. Signals carried by trains (lanterns and disks of various colors) are explained by a number of diagrams.

The electric underground railways of London are described in Chapter VII. Some space is also devoted to the Greathead system of tunneling. The Central London Railway, the future "greatest thoroughfare in the world" and other projects for underground electric railways are briefly described.

Chapter VIII. is devoted to a treatise on the freight traffic of the London railways. The different classes of freight trains, the length and capacity of cars in use, speed and make-up of freight trains, the dispatching of trains at intermediate stations and the trans-shipment of goods are fully detailed. The part treating upon the local freight traffic of London is illustrated by quite a number of diagrams and tables.

In Chapter IX. some notes on the development of the London railways are given, dwelling at length upon the construction of the trunk lines; an account of the present extension of those systems ending the work.

The illustrations accompanying this work deserve special mention, in addition to that which we have already given, as they are all well selected and cleverly designed and drawn. The admirable typographical work upon the volume also deserves mention. It is one of permanent value.

USEFUL INFORMATION, and Data for Travelers, Railway Men and Mechanics. Compiled by T. J. Nicholl, C. E. 2d edition, 32mo, pp. 69. 20 cts.

This is a handy little book of useful hints and tables. And while it is necessarily limited in the quantity of this information, it is very well worth the price asked for it.

BATIMENTS DE LA MARINE FRANCAISE—Liste des Guerre et Commerce, et de leurs Signaux Destinctifs dans le Code International de Signaux a l'usage des batiments de toutes les nations. Janvier 1, 1892. Paris: National Printing Office, 1892, pamph., 8vo, pp. 83. 60 cts.

This is an official list, issued by the French "Service Hydrographique de la Marine," of French war ships and the merchant marine, with their distinctive signals. This list is divided into three parts, as follows: (1) War ships; (2) French yacht clubs; (3) merchant ships. No further description is given than the name, class of ship and its signal number, in the class of war ships. In the case of yachts and merchant ships, the tonnage, horse power and port to which it belongs, is added. house.

QUESTIONS AND ANSWERS ABOUT ELECTRICITY.—A First Book For Students on the Theory of Electricity and Magnetism. Edited by E. T. Bubier. 2d. Lynn, Mass.; Bubier Pub. Co. 12 mo., flex. cloth, pp. 100; 33 cuts. 50 cents.

This little handwork is not to be taken too seriously; it is intended only to satisfy the first curiosity of the "young student or amateur," especially the amateur, we judge; for the student who means business, wants solider food than this. It deals only with superficials, not entering at all into the abstract theory of electricity. Why there should be a parade of the names of four different "authors" on the title page, or why, if these "authors" did their labors even reasonably well, (that of writing some 20 small pages of large type each), there should also be need for an "editor" to lick their contributions into shape, we do not see. Therefore, we have not reproduced the names of the authors.

Yet, withal, it is a handy little book for many readers who want to gather with little labor some of the more salient facts of recent electrical progress. Its faults are almost wholly of omission, not of commission. It is neatly published, and the man in search of elementary knowledge on the subject with the least possible trouble to himself, should easily enough get 50 cents' worth out of it.

U. S. BOARD ON GEOGRAPHIC NAMES.—First Report of. 1890-1891. Washington, D. C. 8vo. pp. 56.

Preliminary reports of this Board have already been referred to. The Board itself was created by an executive order of President Harrison, in September, 1890, and its purpose is to secure uniform usage in regard to nomenclature and orthography throughout the executive departments of the Government, and particularly upon maps and charts. Prof. Thomas C. Mendenhall, U. S. Coast and Geodetic Survey, is the Chairman of the Board. The present report contains about 35 pages of "decisions" as to the proper spelling of local names, and a list of county names in the United States, as decided by the Board.

UNITED STATES JOURNAL OF ARTILLERY. Published by the authority of the staff of the U. S. Artillery School, Fort Monroe, Va. Lieut. C. de W. Willcox, 2d Artillery, Secretary. Vol. I., No. 3; July, 1892. Quarterly. $2.50 per annum.

This is a new quarterly in a special field; and its contributors are almost entirely artillery officers or ordnance engineers. Judging from the contents of the number before us, the papers given are of the utmost value in the practically new study of the theory and practice of modern artillery, as may be indicated in the following list of subjects treated: Theoretical Instruction of Gunners; A Study of the Effect of Smokeless Powder in a 57-mm. Gun; Department of Chemistry and Explosives; The Effect of Accelerating and Retarding Winds Upon Projectiles; Proposed Design for a New Ballistic Target; Field Artillery, Its Organization and Its Role; Trials of a 57-mm. Canet Gun.

TRADE PUBLICATIONS.

GRAPHITE.—DIXON'S PERFECTED GRAPHITE FOR LUBRICATING.—Jos. Dixon Crucible Co., Jersey City, N. J. 12 mo., pamph., pp. 8.

This pamphlet describes again the tests which show the excellent qualities of graphite as a lubricant, now well known, and explains processes of manufacture and use.

The graphite mines of the company at Ticonderoga, are claimed to be the only successful mines in America, and the only mines in the world from which an absolutely uniform flake graphite can be obtained.

SOCIETY PROCEEDINGS.

CENTRAL RAILWAY CLUB.—At the meeting to be held at the Hotel Iroquois, Buffalo, at 9:30 a. m., Sept. 28, the subject for discussion will be the Rules of Interchange.

NEW YORK RAILROAD CLUB.—At the meeting on Sept. 15 an extended description was given of the Baines car truck, which has been in use for about three years under the cars of the Lackawanna Live Stock Express Co. The Pennell water-purging plant for purifying feed-water for locomotive boilers, was the subject of a paper by Mr. F. A. Stinard. The system was described in our issue of June 9, 1892.

THE NEW ENGLAND WATER-WORKS ASSOCIATION.—The annual fall outing of the association was held Sept. 14, at Middleborough, Mass. The members who attended were entertained by the Water Board and the Commercial Club. A shore dinner was given on Lake Assawampset, one of a group of lakes which together form the largest area of fresh water in Massachusetts.

AMERICAN INSTITUTE OF MINING ENGINEERS. —The 63d meeting will be held in the Schuylkill Valley, Pa., commencing Tuesday evening, Oct. 11, 1892. Headquarters will be at the Neversink Mountain Hotel, Reading, Pa. On Wednesday a session will be held in the morning and the afternoon will be spent in visits to local works and points of interest. On Thursday there will be an excursion to Pottstown and Birdsboro, and on Friday one to the Schuylkill anthracite field. It is expected that a discussion on hot blast stoves will be one of the features of the meeting. Hotel rates will be $3.00 per day. Mr. Jerome L. Boyd, of Reading, Pa., is Chairman of the local committee.

ROADMASTERS' ASSOCIATION OF AMERICA.— The tenth annual convention will be opened at 10 a. m., Oct. 8, at Lookout Mountain Inn., Chattanooga, Tenn. After the morning session the Association will adjourn to Atlanta, Ga., to meet at the Kimball House, for the two days following. Committees will report on the following questions: The Best Proportion of Chemicals for the Steel Used in the Manufacture of Rails, and the Weight and Cross-Section Which Will Secure the Best Results. Electric Signaling and Its Relation to Trackwork. A Code of Rules to Govern Track Men. Work Trains and Their Handling by Dispatchers. The Best Mode of Fastening Rails to Ties. Double or Single Target Switch Stands and Their Position on Single and Double Track. How to Take Care of the Right-of-Way and Fences. What Number of Men Can Work to the Best Advantage in Re-laying Steel, and How Should the Work Be Divided to Secure the Best Results."

The Committee on Arrangement have planned for a tour of South Carolina and Florida, including the cities of Charleston, Jacksonville, Tampa and St. Augustine.

J. H. K. Burgwin, Secretary.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the September meeting of the club, held Sept. 11, Prof. C. H. Benjamin, of the Case School of Applied Science, read a paper on "Some Experiments on the Effect of Punching on Soft Steel."

The experiments described were made at the mechanical laboratory of Case School of Applied Science, under the direction of the writer, and had for their objects, first, the determination of the ultimate resistance to shearing of soft steel plate for different forms of punch; secondly, the determination of the effect of the punching on the elastic limit, and ultimate tensile strength of the plate in the various cases.

In every test the material used was Otis steel boiler

plate, ¼ in. thick, and stamped 60,000 lbs. tensile strength, the pieces all being cut from the same plate. The experiments showed that the average resistance to punching with the common forms of punch was 50,000 lbs. per sq. in., while with the spiral punch it was only 38,000 lbs. They showed also that punching a plate with ordinary forms weakened it 7½%, while the use of the spiral punch only weakened it 3%.

A considerable change in clearance affected the results but slightly, but good or bad centering of punch and die was very noticeable in its effects.

C. S. Howe, Sec.

MASTER CAR BUILDERS' ASSOCIATION.—The Secretary announces the following subjects and committees for the convention of June, 1893.

In accordance with the recommendations of the committee on M. C. B. Standards in its report to the convention in 1892, and in pursuance of instructions from the convention to the Executive Committee, the following four committees are appointed:

Committees on M. C. B. Standards.

1. Drawbars and Brake Beams.—To consider the suggestions of the Committee on Standards, as to the standard height of drawbars, and as to standard form of brake beam, and report with recommendations and drawings in detail: Messrs. E. D. Nelson, John Bean, J. R. Rankin, C. A. Schroyer.

2. Axles, Journal Boxes, Lids and Wedges.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published: Messrs. R. H. Soule, W. H. Day, W. H. Lewis.

3. Truck Pedestals and Safety Chains.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published: T. A. Bissell, Wm. McWood, A. E. Mitchell.

4. Protection of Trainmen and Lettering Fast Freight Line Cars.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published. Messrs. E. P. Lord, Robert Walker, Thos. Sutherland.

Miscellaneous Committees.

5. Tests of M. C. B. Couplers.—To arrange for and conduct the tests, as proposed by the committee of 1892 and approved by the convention, and to consider and report upon all other questions connected with the M. C. B. coupler, which they might consider advisable, with the exception of the attachment at the rear end of the coupler and the form of the coupler at that point. To confer with the Committee on Attachment of M. C. B. Couplers to Cars: Messrs. J. M. Wallis, J. S. Lentz, R. D. Wade, J. H. McConnell, E. Chamberlain, T. G. Duncan.

6. Attachment of M. C. B. Couplers to Cars.—To recommend a form, in detail, of M. C. B. coupler at rear, and so as to take yoke, tail bolt and continuous drawbar attachments; also, to consider and report upon the best form of draft attachment to cars. To confer with Committee on Tests of M. C. B. couplers: Messrs. E. D. Bronner, W. H. Harrison, A. M. Waitt, Wm. Garstang, A. Dolbeer, Jno. H. Davis.

7. Metal for Brake Shoes.—To investigate the relative friction and wear of different metals and different shoes in general use on chilled treads and on steel tires: Messrs. Wm. Forsyth, Benjamin Welsh, F. D. Adams.

8. Cast Iron Wheels.—To investigate and report whether there is any substantial difference in wheels made by different methods, such as by solid chills or contracting chills, or by any other difference in process of manufacture: Messrs. G. W. West, W. H. Thomas, Jno. Player.

9. Steel-Tired Wheels.—To investigate further and report with all data available as to relative values in service: Messrs. R. E. Marshall, J. O. Pattee, C. H. Cory.

10. Air Brake Tests.—To investigate and report in detail what tests are desireable to insure best available service: Messrs. G. W. Rhodes, E. B. Wall, Geo. Gibbs, A. S. Vogt, E. A. Williams.

11. Freight Car Truck Frames.—To include in its report the relative advantages of Fixed Bolsters and Swing Bolsters: Messrs. J. C. Barber, W. S. Morris, S. A. Crone.

12. Steel Center Sills.—To consider and report whether the use of steel for center sills in freight cars would be desirable: Messrs. D. L. Barnes, J. N. Barr, J. D. McIlwain.

13. Steam Heating and Ventilation of Passenger Cars.—To review the report of last year's committee on this subject, which was acted on provisionally, and to recommend any changes that may be deemed proper; also, to further pursue the subject of steam heating in general, informing the Association as to what improvement, if any, is being made over the methods now in use: Messrs. L. B. Paxson, J. J. Hennessy, Jos. Townsend, John Hodge, David White.

JNO. W. CLOUD, Secretary.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting of Sept. 7, the first paper read was on "The Increasing Cost of Railway-Tie Renewals," by Benjamin Reece, M. Am. Soc. C. E. It was briefly discussed by the President, who stated that in his time when the iron rails were worn out it was cheaper to take out the ties and renew them than to put down old ties. They found the half-worn ties were being used as fence posts near the line of the road, and it became necessary to require that no old ties be sold, but that all be burned.

A paper on "Thin Floors for Bridges," by Albert F. Robinson, M. Am. Soc. C. E., was discussed by Messrs. T. C. Clarke and George S. Morison. Mr. Clarke said that there were two points to be considered—first, that of renewal of the floor; the other, that of deadening the noise. A lighter material for ballast of such floors would be an excellent thing. The concrete mentioned, in which coke is used instead of stone, would make too solid a bearing and lack elasticity. Rails directly on the iron would cause too much noise. The New York Central plan of bedding the ties in ballast seemed best. On the Alton Railroad burned clay was used, but it caused much dust. Reference was made also to the track of the elevated railway in Liverpool. Mr. Morison described the use of such a floor on the city bridge in Omaha to carry 13 tracks over a street, requiring it to be tight. He detailed the difficulties of the location, requiring the lowest possible position of the rails, and the character of the truss and floor. One of the great advantages of such a strong floor was shown in the way in which the bridge withstood a flood which brought great numbers of trees against it.

At the meeting of Sept. 21 the first paper to be read will be on "The Strength and Weathering Qualities of Roofing Slates," by Mansfield Merriman, M. Am. Soc. C. E.

This paper is based on a careful examination of slates from Northampton Co., Pa. Geologically, these deposits belong to the formation called the Hudson River slates. They dip toward the northwest, and have a thickness of 6,000 ft. perpendicular to the dip. The geological structure of the formation is very complicated. The original planes of stratification are usually marked by seams or ribbons, which traverse the rock in approximately parallel directions, and which differ in color and composition from the slates proper. The planes of cleavage are not parallel to these ribbons, but the angles made vary in different quarries.

The outcrop near the top of the formation, near the base of the Blue Mountain, produces the soft slate used for roofing and school slates. The outcrop near the bottom of the formation, several miles away, produces the hard slates used for sidewalks and steps. In the upper beds the ribbons are soft and of inferior quality to the slate proper; in the lower beds they are often harder than the slates.

The slate deposits are covered with earth and gravel to the depth of from 10 to 50 ft. After removing this and the weathered outcrop, the slate is quarried by drilling holes at right angles to the cleavage planes, and blasting out large blocks, which are broken into smaller blocks about 1 or 2 ft. thick, 2 or 3 ft. wide, and 8 or 10 ft. long. These are removed to shanties, and there split, first, into thicknesses of about 2 inches. These are subdivided, and the parts again divided, the process continuing until the required thickness of about 3-16-in. is reached. The rock splits best when damp.

Numerous sizes are made, varying from 6×12 to 14×24 ins. In proper roofing, a triple lap of 3 ins. is allowed; thus, for a 24-in. slate, 10½ ins. of each slate are uncovered, 10½ ins. are covered by one thickness, and 3 ins. by two thicknesses. The amount of slate required to cover a space 10×10 ft. is called a square.

The best slates are called No. 1 stock. Those with one ribbon crossing them are No. 1 Rib, and those with two ribbons No. 2 Rib. The slates from the Albion quarries at Pen Argyle, and from Bangor (here investigated) are of a dark bluish gray. On exposure to the weather, the ribbons effloresce and show signs of decomposition, due to the sulphide of iron contained. Such slates should not be allowed on permanent work.

The tests detailed in the paper were made for strength, hardness and porosity. The pieces tested were $12 \times 24 \times 3$-16 to ¼ ins. and were all free from ribbons, 12 being taken from each of the quarries mentioned. The slates from the Bangor quarry were somewhat more even in surface and slightly darker. In testing, the slates were supported on wooden knife edges 22 ins. apart, and the load was supported by another knife edge midway between them. The load was applied by means of sand running from an orifice at the rate of 70 lbs. per minute, and the modulus of rupture was obtained in pounds per square inch. The slates from the Bangor quarries gave values of 8,100 to 10,235, with a mean value of 9,810. Those from the Albion quarries, 7,150 lbs.

The ultimate deflection was measured in each case, and gave an indication of the toughness of the specimen, since the greater the deflection the tougher will the specimen be. The deflection of the Albion specimens averaged 0.270 ins., and that of the Bangor 0.313 ins. The first broke with a squarer rupture, and showed more lamination.

The hardness of the slates was tested by abrasion upon a grindstone under a constant pressure, and for a given number of turns. The loss of weight by the Bangor specimens was 60% more than by the Albion, showing that the latter is best for places where hardness is a requisite, as when it is used for sidewalks.

Absorption tests showed 10.238% of water absorbed in weight by the Albion, and 0.145% by the Bangor, in 24 hours. Tests for corrosion by a 2% solution of equal parts of nitric and hydrochloric acids in water showed somewhat in favor of the Bangor slates.

The following conclusions were reached for the slates tested: 1. Slates containing soft ribbons are inferior, and should not be used in good work. 2. The soft roofing slates weigh about 175 lbs. per cu. ft., and the best qualities have a modulus of rupture of from 7,000 to 10,000 lbs. per sq. in. 3. The stronger the slate the greater is its toughness and softness, and the less is its porosity and corrodibility. 4. Softness, or liability to abrasion, does not indicate inferior roofing slate, but is an indication of strength and good weathering qualities. 5. The strongest slate stands the weather best, so that a bending test affords an excellent index of all its properties. 6. The strongest and best slate has the highest percentage of silicates of iron and aluminum, but is not necessarily the lowest in carbonates of lime and magnesia. 7. Chemical analyses give only imperfect conclusions regarding either durability or physical properties. 8. Bending tests should be required by specification. 9. It is suggested that specifications should require roofing slates to have a modulus of rupture, by flexure, greater than 7,000 lbs. per sq. in.

The second paper of the evening will be on "Tests of Power Required to drive Electric Street Cars, and Total Efficiency of the Motor," by Louis B. Bonnett, Jun. Am. Soc. C. E.

The last paper will be on "Motive Power for Street Railways," by Alfred F. Sears, M. Am. Soc. C. E.

The last two of these papers were presented at the Annual Convention, but were not read for lack of time. Abstracts were published in this journal at the time of the convention.

COMING TECHNICAL MEETINGS.

DENVER SOCIETY OF CIVIL ENGINEERS AND ARCHITECTS.
Sept. 27. Secy., Geo. H. Angell, 36 Jacobson Block.

CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Macbeth.

SWEDISH ENGINEERS' CLUB.
Oct. 1. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
Oct. 1. Union Station, St. Paul.

ENGINEERS' CLUB OF PHILADELPHIA.
Oct. 1. 1122 Girard St. Secy., L. F. Rondinella.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Oct. 3. Secy., C. L. Annan, City Engrs'. office.

WESTERN SOCIETY OF ENGINEERS.
Oct. 5. Secy., Jno. W. Weston, 54 Lakeside Building, Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Oct. 5. Secy., F. Collingwood, 127 East 23d St., New York

ENGINEERS' CLUB OF ST. LOUIS.
Oct. 5. Secy., Arthur Thacher, Odd Fellows' Building.

ENGINEERS' CLUB OF MINNEAPOLIS.
Oct. 6. Secy., F. W. Cappelen, 1628 Hennepin Ave.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Oct. 7. Secy., E. K. Smoot, 503 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Oct. 7. Secy., O. Von Geldern, 719 Market Street, San Francisco.

WISCONSIN POLYTECHNIC SOCIETY.
Oct. 9. Secy., M. G. Schinke, City Hall.

ENGINEERS' CLUB OF KANSAS CITY.
Oct. 9. Secy., Waterman Stone.

NORTHWESTERN SOCIETY OF ENGINEERS.
Oct. 11. Secy., F. H. Warner, Seattle, Wash.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Oct. 11. Secy., Chas. S. Howe, Case School.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Oct. 12. Wichita, Kan.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Oct. 13. Secy., Edward Mead, Norton Building.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Oct. 13. Secy., E. N. Clark, Pittsburg, Pa.

WESTERN RAILWAY CLUB.
Oct. 12. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERING ASSOCIATION OF THE SOUTH.
Oct. 13. Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Oct. 14. Secy., D. W. Meeker, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Oct. 15. Secy., F. D. Jones, Helena.

ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.

AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 19, 20, 21. Cleveland, O. Secy., Wm. J. Richardson, Brooklyn, N. Y.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Oct. 19. Secy., S. E. Tinkham, City Hall.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Oct. 20. Secy., C. F. Franson, 113 Adams St.

NEW YORK RAILROAD CLUB.
Oct. 20. Secy., H. G. Prout, 73 Broadway, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
Oct. 20. Secy., J. F. Wilson, 24 W. 4th St.

TACOMA SOCIETY OF CIVIL ENGINEERS AND ARCHITECTS.
Oct. 21. 201 Washington Building.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 21, 22. Roanoke, Va. Secy., J. R. Schick, Roanoke.

NEW ENGLAND RAILROAD CLUB.
Nov. 14. Secy., F. M. Curtis, O. C. R. R., Boston.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., J. A. Charpiot, Macon.

CENTRAL RAILWAY CLUB.
Nov. '93. Secy, S. W. Spear, E. Buffalo N. Y., Iron Works

ENGINEERING NEWS

AND

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CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50; 4 months, $2.00; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

One of the founders of American engineering has passed away this week, full of years and honors. We have endeavored in another column to do some scant justice to his professional career, the story of which can in a measure be told. But what cannot be told is that charm of personal presence, that benignant and cordial atmosphere of peace and good will, that spirit of love for his profession for its own sake and not for what he could make out of it, that kindly interest in those who were growing up to follow him, which made Mr. Francis a loved and honored guest at every gathering of engineers, and which will make the news that his blameless life is over come to hundreds of them, as it does to us, like a personal grief.

In order that full justice may be done to all competitors for the prizes offered by us for the three best graduating theses of 1892, we find ourselves compelled to postpone the announcement of the awards, which was promised for Oct. 1, for at least 60 days. A considerable number of very creditable theses have been received, and the task of deciding justly amongst them is one demanding more time than we had foreseen.

The paper on electrical meters in another column is so far as we know the most complete and valuable one on this important subject which has ever been made public. It is interesting to notice the high credit which the author gives to the work of American inventors in this direction compared with that of their competitors abroad. His remark concerning Prof. Elihu Thomson's meter, that it leaves little to be desired, is especially noteworthy in connection with the fact that a prize of 5,000 fr. recently offered by the city of Paris to the inventor of the best electric meter was awarded to Prof. Thomson.

There seems to be little doubt that the direct reading type of meter is the type that will eventually supersede all others. The chemical meters may register with great accuracy and be comparatively very cheap; but the customer cannot read for himself their records as he now reads his gas meter and water meter, and in the long run this difference insures the use of direct reading meters.

The accuracy of the various meters is a matter of great importance, and Mr. Swinburne's paper shows that there is much variation in this respect. The best meters seem to be able to register as closely as the best water meters, say with an error of ½ to 2%; but whether they will maintain this accuracy after years of constant use (and perhaps abuse) is a question yet to be determined. It is true that the electrical current cannot carry foreign matter to get into the meter and injure it as does the current which flows through a water meter; but the very minute amount of energy which the meter uses makes delicate mechanism a necessity in its construction, and it is generally supposed that delicate and intricate mechanism is liable to suffer by neglect.

The manner in which the principal electric meters operate is something with which engineers should familiarize themselves. Sooner or later questions concerning the accuracy of the various types of meters will be the subject of litigation, and to be well informed on this subject may enable an engineer to save those whom he serves from heavy loss or to save himself from the reproach of ignorance. For example, Mr. Swinburne points out that one type of electric meters for measuring alternating currents varies its record according to the frequency of the alternations. Apparently, then, all the central station manager has to do, in order to convert a heavy loss into a splendid profit, is to weaken the fields on his dynamos and run them faster. The consumer will receive the same electrical energy as before, but the number of alternations per second being increased, the meter will make a higher record. Suppose a city engineer has charge of the sale of a franchise for electric lighting to the highest bidder, (a manner of procedure which is not as common as it ought to be). An unprincipled party might outbid every reputable firm and agree to give as low rates as they, recouping himself by using meters of the type above mentioned and running his dynamos in the manner suggested. With the present popular ignorance concerning electrical matters, he would run no very great risk of being found out in many cities, which have no electrical experts in their service.

The lists of subjects on which committees are to report at the next Master Car Builders' convention, as announced in another column, makes ample provision for carrying out the recommendations of the last committee on revision of the M. C. B. list of standards, by appointing four separate new committees to consider and report upon the several recommendations of the last committee. Two new committees on automatic coupler standards are also appointed, one to recommend standard connections and one to "arrange for and conduct tests" but not to go so far as to recommend rules for standard tests unless they see fit. The instructions for the committee on air brake tests are similarly guarded, or even more so. It is of extreme importance that a schedule for standard tests of brake plant should be drawn up as soon as possible which will exclude from authorized use all brakes which cannot safely be used interchangeably, but exclude none other. The committee is only instructed, however, to investigate and report upon "what tests are desirable to insure the best available service," which seems to imply that the aim of the tests which they may report is to be only for individual information. The subject is a delicate one, and affects important business interests in and out of railway service, and it may be that this cautious wording is to avoid all appearance of promising to do more than may prove to be certainly warranted. The committee is a strong one, headed by Messrs. Godfrey W. Rhodes and E. B. Wall, and it will certainly appreciate as strongly as anyone that as soon as a code of standard tests can be drawn up intelligently it should be established. Possibly they may be prepared to recommend one at the next convention. Another committee whose report will probably be interesting and possibly important is that to consider and report whether the use of steel center sills in freight cars would be desirable. The metal frame car is certainly coming; it may possibly come little by little instead of all at once.

The danger of cholera seems to be pretty well over for this year, thanks to an efficient quarantine and to the city Health Department, both of which deserve the thanks of the public, despite some mistakes which caused needless annoyance and distress to individuals. Some foolish newspapers (especially those whose editors were sufferers at quarantine) have urged that all quarantine laws were relics of barbarism, pointing to the British practice and to the appearance of a few sporadic cases in New York despite the quarantine as proof that it is both superfluous and ineffectual. But Britain lives only by its shipping, so that it dare not check it seriously. To do so even for a few weeks would mean a material increase in the price of the necessities of life; while who can say what might be New York's situation to-day had the quarantine regulations been less stringent? It must not be forgotten for a year to come at least that the peril is a continuing one and does not end with the present season either for Western Europe or America. In fact the danger next year may be even greater than this if our temporary escape should breed a false security. According to the report of Mr. Chas. Emory Smith, our Minister at St. Petersburg, from 14,000,000 to 16,000,000 people living on an area ten times as great as the State of New York are now in want of the commonest necessaries of life. Through this vast and helpless population the cholera is now spreading, giving a nucleus of contagion such as Europe has never known before. Judging from past experience it will take at least a year for its full effect to spread. Modern sanitary improvements may make this terrible source of infection more easily manageable than much less ones have been before; experience so far seems to indicate that it may. But it certainly will not unless the greatest care is taken and maintained throughout all the countries threatened through the present winter at least. The danger is that with the ceasing of actual new cases of cholera precautions against spreading its germs will relax. Especially is this true of the approaching World's Fair, at Chicago, where the coming of merchandise, visitors and baggage from all parts of the world may easily plant the germs of disease before the danger is realized. As Chicago still pours much of its sewage into its source of water supply, with results visible in its chronic excess of typhoid fever deaths, and as it proposes to continue to do so indefinitely, the danger there especially demands unceasing watchfulness.

At a time when there seems to be only a rapidly widening breach between master and man in the industrial centers of this country, the following item from the London "Times" correspondent in Essen, Germany, is at least suggestive: According to this item, the town of Essen erected a statue to the memory of Alfred Krupp, soon after his death in 1888. But the workingmen resolved that that monument was not sufficient to mark their love and devotion to the man who had ever by his counsel and many acts of benevolence shown himself to be truly their friend. A voluntary subscription was raised, and lately another statue was erected strictly as a mark of the workmen's esteem. Men from their own ranks made the speeches at the unveiling, and 17,000 workmen marched past the son of their benefactor and by their respectful reverence showed that they looked upon him, in turn, not as a mere payer of wages, but as a man and the son of a man who had their interests at heart as well.

That workmen should erect a monument to a late employer is suggestive of pleasant relations, and is in itself not a common occurrence. But that the men of Essen had more than passing occasion for gratitude for favors past and for faith in the successor to Alfred Krupp is shown by the manner in which his son met this expression of good feeling. After the statue was unveiled Mr. F. A. Krupp acknowledged this act of his men with deep feeling and informed them that he would at once expend $125,000 in the erection of cottages, with gardens, for the infirm and invalided among his workmen and for the widows of men who had died in his employ.

We have before argued that one of the chief causes in the changed relations between master and man, as compared with the conditions of a century ago, is that the great number of men now employed in a single establishment tends to destroy personal relation and personal interest between them. But here is a case where one of the greatest employers of labor of modern times has succeeded in keeping in touch with his men, and is proving to them by good deeds performed that he still regards his workmen as men capable of appreciating acts of kindness, and not as mere machines or beasts of burden. There is a lesson in the Krupp policy of handling workingmen that might be profitably learned by some of our own employers of labor.

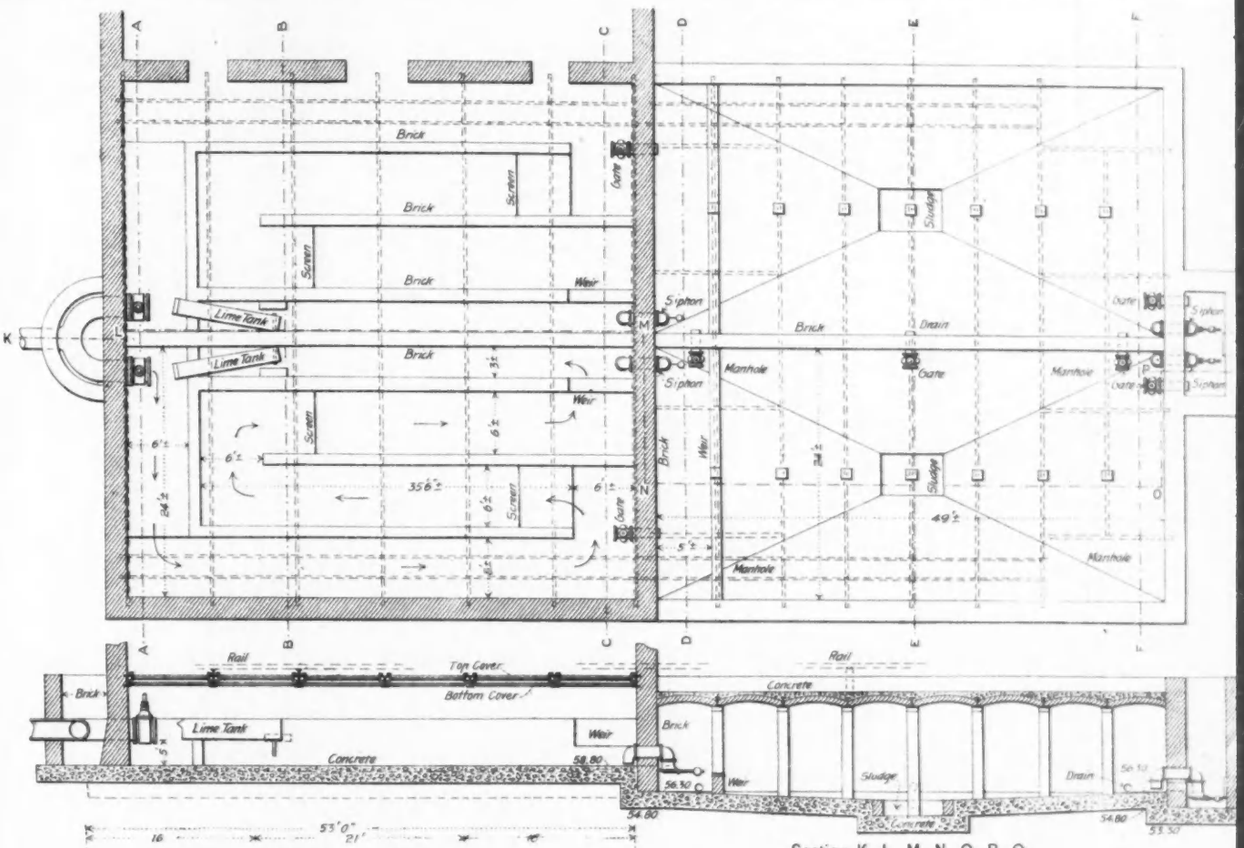


FIG. 13. PLAN AND LONGITUDINAL SECTION OF TANKS.

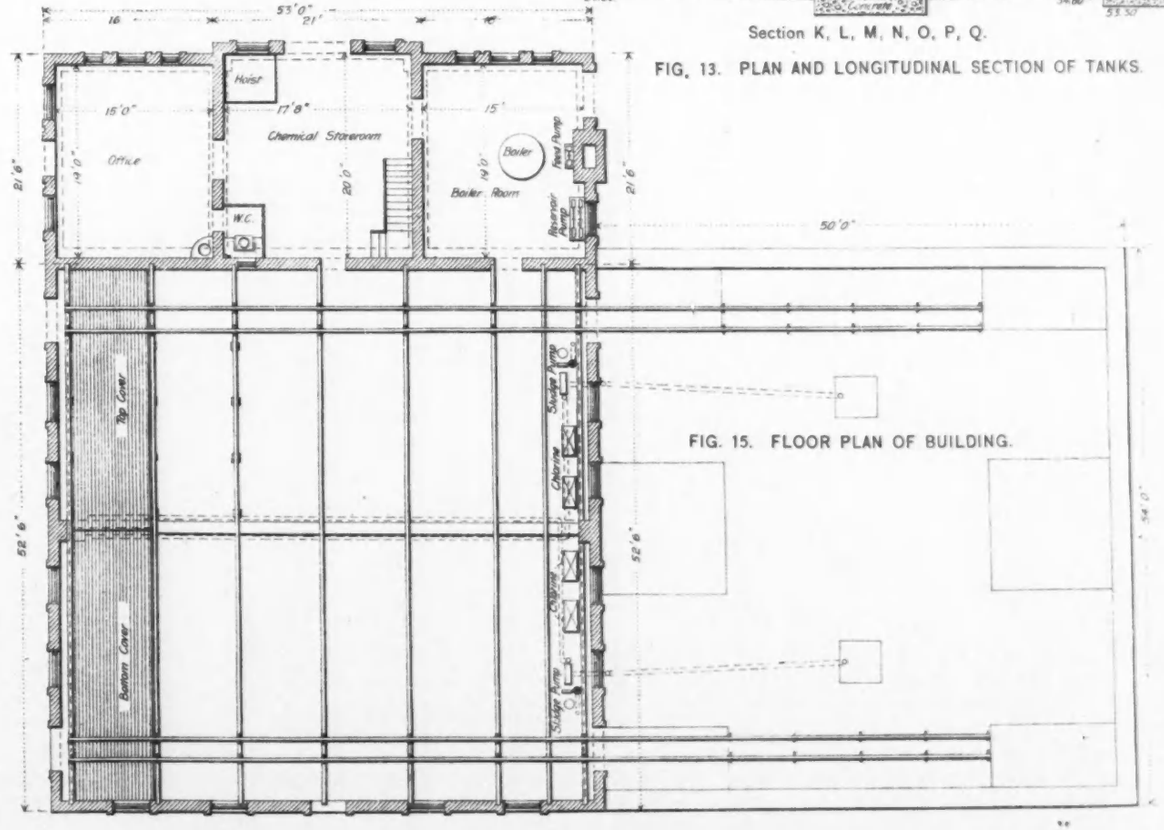
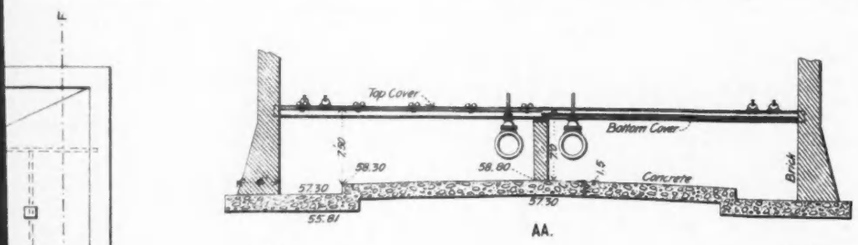
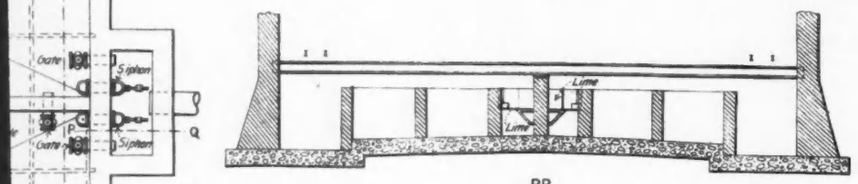
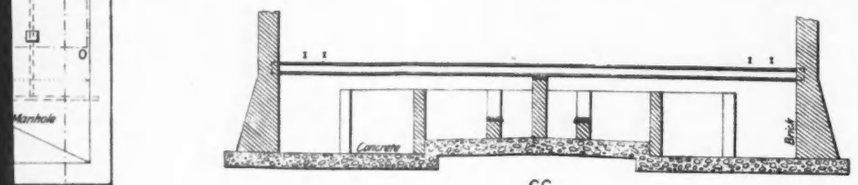
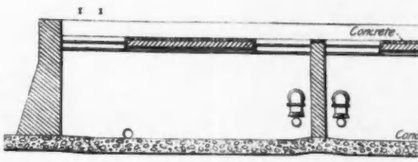


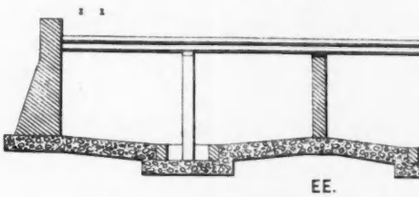
FIG. 15. FLOOR PLAN OF BUILDING.











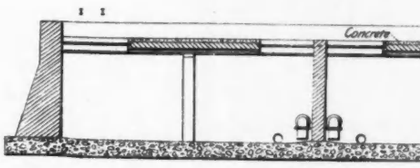
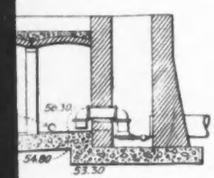


FIG. 14. CROSS-SECTIONS THROUGH TANKS.



OF TANKS.

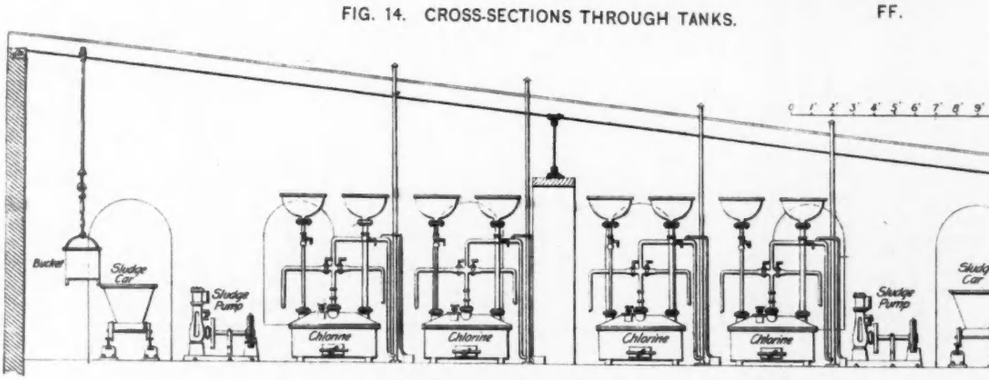


FIG. 16. CROSS-SECTION SHOWING CHLORINE GENERATORS.

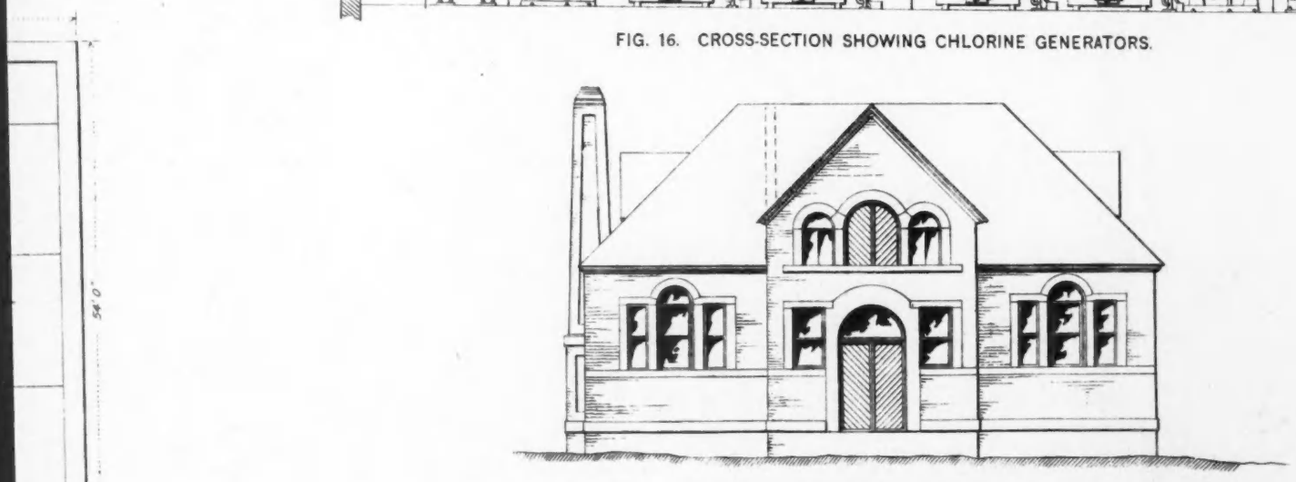
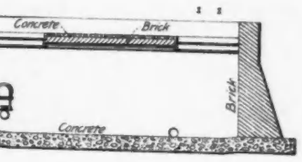
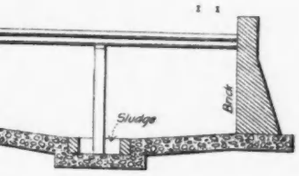


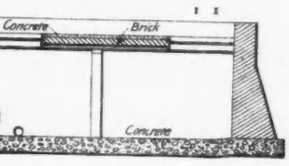
FIG. 17. FRONT ELEVATION OF BUILDING.

SEWAGE PURIFICATION PLANT AT WHITE PLAINS, N. Y.

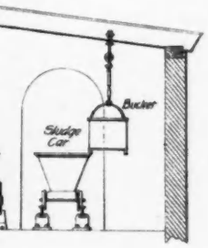
J. J. Powers, Designing Engineer.







6' 7' 8' 9' 10'



CHAS. HART & SONS, LITH. 32 VESEY ST., N. Y.

REORGANIZATION OF THE LAWRENCE SCIENTIFIC SCHOOL.

We learn with great satisfaction from public and private sources of information that an earnest effort is now making to recover lost ground on behalf of this old and well known school, and to put it at last where it should have been from the first (and was for a decade or so after its foundation), near the head of the list as a school of practical engineering. In the appointment of Prof. Wm. H. Burr to take charge of the department of engineering, an important step in advance has been taken. Few colleges of engineering have in their service a better qualified man for the position. But besides this, the authorities of Harvard University have already arranged to add two additional instructors during the present year, one in highway engineering of many years practical experience in that art since graduating from the Coast Survey service, and one in sanitary engineering, who has not yet been finally selected. It is also expected to add at once to the staff additional instructors in constructive architecture and mechanical engineering. An excellent mechanical and electrical laboratory (for a beginning) will also be available hereafter, having been in process of formation for some months. With the three or four able and faithful men who are already connected with the school, and with the professors of chemistry, geology, physics, mathematics, etc., attached to the general college faculty who also serve this school, this makes a staff which will compare favorably with that of many schools having a much larger number of yearly graduates. If the staff of instructors is further increased as the number of students increases, if the standard of qualifications for admission and for graduation is kept high, and if the university authorities atone for the neglect of the past by showing a little extra attention and favor to the school while it is recovering from the strange neglect of over 40 years, we may yet see it occupying among schools of engineering some such a place as its parent university has long occupied among universities.

We need not say that we shall take especial pleasure in seeing and aiding, so far as may be in our power, its rise to such a standing; all the more because we have recently had occasion to criticise its past record with what may perhaps have seemed some severity. Properly speaking, however, we did not criticise it at all otherwise than by getting together in connected form the facts of its history, beginning with a forgotten letter from its founder, and a pledge of the corporation to use "their best efforts to carry faithfully into execution the enlightened suggestions with which the letter is filled;" and ending with neglect amounting to utter forgetfulness of both the letter and the spirit of this document. Such are the undeniable facts, standing out broadly on the record. If to recite them is to criticise, we have criticised; not otherwise.

If this record is about to change; if the university is at last about to fulfill its long neglected pledge "to carry faithfully into execution" the truly enlightened suggestions of its founder, it will be a most fortunate event, not only for its own honor and credit but for the cause of education generally. For it would be difficult to exaggerate the harm done by such a prominent instance of the total failure of a benefactor to accomplish the end he aimed at, and to secure which he himself did quite enough in money, and much more than is usual in the way of carefully detailed and wise advice. Already the impression is too common among men of wealth that it is dangerous business to leave money for any public use because it is so difficult to have the gift well managed so as to accomplish anything after they are gone. The belief may be well founded or ill founded, but it is widespread. As an evidence thereof, which is not known to the public but of which the present writer happens to know all the facts, a very large fortune amounting to several millions was in fact though not in form left to be used for public ends some years ago and is at this moment awaiting distribution in the hands of its present nominal owner and real trustee, the expressed reason for not distributing it by will having been that it was "easy to give but hard to insure proper use and real benefit."

How much is such an instance as the Lawrence Scientific School of the failure of a donor to attain his real purpose calculated to strengthen and to spread such a belief? From its first foundation until now (or until a few years ago), the very life-blood of the school was sucked away to give instruction in zoology, botany, natural history, and what not, against both the letter and the spirit of the founder's command that "the whole" of the foundation was to be "forever" devoted to instruction in engineering and its allied arts. We do not allude to the administration of funds only, or chiefly. A part of the revenue of the foundation was used in this way, most wrongfully, but what was far worse than this misuse of money was the diversion from the school of engineering of that watchful and loving care which the infant school needs even more than the infant child to bring it to a healthful maturity.

Deprived of this the infant school and the infant child must alike languish. Why the Lawrence Scientific School was thus neglected it would be hard to say; perhaps from the same ignorance as to "What is civil engineering?" which the great Channing showed about that time, despite all his learning, in the amusing anecdote narrated by Mr. Freeman in a recent contribution to these columns. Undoubtedly the book-learned men who then controlled Harvard had little realizing sense of what engineering was or was to be, while they did keenly realize what a nice thing it would be to have a fine Museum of Comparative Zoology at Cambridge, and thus sought to aid Agassiz in every way possible to found it, forgetful of the letter of their pledge.*

Undoubtedly, too, the neglect of every other feature of the Lawrence Scientific School to aid these zoological ambitions was done without the slightest thought or consciousness of wrong doing or of neglect of plighted faith; but by what code of law or morals is the absence of evil intent an excuse for wrong-doing? If I am trustee of an estate, and conclude that without injuring my ward I may lend my friend some of the money to start in business, and that money is lost (or not lost for that matter) am I not dishonored? I am, perhaps, not spotted morally, if my intent was in fact good, but I shall no longer enjoy nor deserve the reputation of an honorable man among those who know the facts. I am under the most sacred obligations to make good that loss to those who have suffered by it, as the first aim of my life.

And wherein is the moral difference between such conversion of money in trust to the use of a friend, and the conversion of money and effort and care and prestige which have been solemnly pledged to the foundation of a school of engineering, to the creation and foundation of a zoological museum?

We perceive no difference and yet the record published by us in May last shows that this was precisely what was done. The very existence of any stipulations by Mr. Lawrence seemed to have been forgotten from the first. At least, neither the letter itself nor any reference or allusion to its contents appeared in any of the many printed documents which we consulted. We obtained the text of the letter only from a copy of an old newspaper in the library. Doubtless the letter itself exists in the archives of the college, but we have a shrewd suspicion that it is somewhat dusty, like the old newspaper which was unearthed for us. Of any faintest reference to any documents relating to the college of later date than 1847 we found no trace.

Not for the base or trivial motive of casting reproach upon those who beyond doubt meant well, and acted for the best according to their lights in this matter, do we again rehearse these facts, but to make it clear why it appears to us that the university still rests under a solemn and continuing obligation to retrieve the consequences of its past neglect even at much sacrifice of other aims. One curious evidence and proof of this neglect is that, barring some possible trivial gifts, not a penny has been given to the school during the period of over 40 years in which new engineering schools by the dozens have been founded and risen to prominence, and have received frequent further gifts. In the whole length and breadth of this land, is there another school or college of any kind, started with some prestige and grounds for hope behind it, which has had no gifts of moment in forty years?

There possibly may be one, but in our recent extended investigations into the history of American Engineering schools we have not run across such an instance; while we do know that almost every other institution of like initial standing, and every other branch of Harvard University without exception, has received many and large gifts during the period in question. But why should any man give money to an institution to which the very university which controls it gives neither thought nor care? He would show himself a fool to do so; and therefore men having money to give to engineering schools (among whom have been a number of Harvard graduates) have given it elsewhere, and found plenty of chances for doing so to advantage.

Is the fact of such neglect denied and the proof challenged? It is possible to deny it indeed, but only by making one concession which no reasonable man will either claim or concede, viz., that the average management of the university during all this period since 1847 has been exceptionally incompetent. For during that period, and since the Lawrence Scientific School was founded, more than one hundred engineering schools have been founded which are now flourishing institutions. A large proportion of these were started with less initial funds than Abbott Lawrence's first gifts of $100,000. It had but two predecessors and rivals when it was founded, both then weaker than itself. No one of these later schools was aided by a prestige as great as that of Harvard University, and few of the greatest of them were aided at all by any prestige of any institution. No one of them was founded in a better center for recruiting students, as events have since proved. No one of them had such a body of rich alumni to count upon for aid so soon as it was needed and desired. No one of them was aided in its formation by a sounder outline of just what an engineering school should be.* No other of any prominence has failed to attract further gifts as it needs and usefulness expanded; no other of any prominence has ever gone backward for more than a few years at a time.

As, therefore, the school which had the greatest advantages of all in time, place and parentage is the only one which has gone backward, there is no possible escape from the conclusion that it has been mismanaged somehow, and only two horns to the dilemma of mismanagement; that it has been mismanaged from incompetency or mismanaged from indifference or neglect. As the general history of the university makes any charge of incompetence wholly untenable the other horn of the dilemma is alone left to us. And with this, all other known facts of the record are entirely consistent.

We hail with satisfaction the evidence narrated that the era of indifferent neglect at least is over. It is the only danger which has ever threatened the school; it is the only serious impediment which even now stands in its path. There is plenty of time to retrieve the past; engineering education is yet young, and has yet to grow greatly both in quantity and quality. Moreover, there is now a plainer necessity to retrieve the past than ever before. He is but a shallow observer of the drift of events who does not see that scientific education is to constitute a more and more dominating fraction of the whole.

The day is passing, if it has not passed, when a university will be anything but ridiculous which

*"The three great practical branches to which a scientific education is to be applied amongst us are, 1st, engineering; 2d, mining, in its extended sense including metallurgy; 3d, the invention and manufacture of machinery. These must be deemed kindred branches, starting from the same point and gradually diverging to their more special applications. Mathematics, . . . chemistry, . . . geology, mineralogy, . . . carpentry, masonry, architecture and drawing are all studies which should be pursued to a greater or less extent in one or all of these subdivisions. . . . I cherish a wish to see the observatory . . . ready for use, and do not intend to interfere with (the accomplishment by others of) this great object. Nor do I mean to occupy the ground of another branch of science that will, I suppose, at a future time, present strong claims upon the public bounty. I allude to natural history. I beg to suggest further that the whole income of this school be devoted to the acquisition, illustration and dissemination of the practical sciences forever. . . . I now leave the whole subject in the hands of the gentlemen composing the Corporation." (Letter of gift of Abbott Lawrence, June 7, 1847.)

"It is deemed by the Corporation a high privilege, and a great reward for their labors, to be the stewards of such bounty; and they pledge their best efforts to carry faithfully into execution the enlightened suggestions with which the letter accompanying the donation is filled." (Resolution of Acceptance by the Corporation of Harvard College, June 7, 1847. For both documents in full see Eng. News, May 5, 1892, p. 460-61.)

* We have since learned from the letter of Mr. John R. Freeman, published in our issue of Sept. 1, how it happened that Mr. Lawrence had the requisite technical knowledge of what an engineering school should be to draft such an excellent letter of advice as he did. It appears that he was largely indebted to the advice of his friend Mr. Chas. S. Storrow, one of the most eminent and thoroughly educated of our early engineers, and to-day perhaps the oldest living civil engineer.

claims to be a university of the first rank and does not include a high grade engineering school. This could not be foreseen fifty years ago, but no one can fail to see it now; or to see that the old-time A. B. course is to a large extent a mere survival, which will be chosen by a smaller and smaller proportion of college-bred men. We must not be misunderstood to advocate purely utilitarian training for any class of men, and least of all for engineers, or to believe that such is to be the education of the future. We don't undervalue that broadening of the mental faculties which can be had, perhaps best of all, by a moderate amount of training in the old-time "classics." On the contrary, we have contended and shall contend that technical education is now too purely utilitarian; so narrow in its scope and spirit that it handicaps its graduates in the work of life by a too one-sided and narrow training. A great future, we believe, awaits that engineering school which will either demand or give a broader general training as the condition of graduation from the scientific courses. But the day is past when any university can safely treat the practical scientific professions as mere handicrafts, and ignore them in its organization.

Even if this were not so there is another practical reason why a university should treat its engineering schools respectfully. Modern fortunes are made chiefly in the scientific callings, as they were not fifty or twenty years ago. Men of fortune only give to colleges. Colleges cannot live and grow unless money is given to them. Men give most to what interests them most; they are interested most in what they know most about. From a mere money point of view, where will Harvard or any other university be fifty years from now which persistently ignores engineering education in its scheme of instruction? It will be nowhere; a decaying relic of the past.

We rejoice at the evidence that these truths are at last perceived, and that the Lawrence Scinetific School is at last to be put upon its proper plane of efficiency. The effort only is enough, and has been any time these fifty years. The effort really made, it will undoubtedly succeed.

LEGAL DOCUMENTS OF INTEREST TO ENGINEERS.

Setting Aside Engineer's Calculations.

A contract was made with an irrigation company to construct a canal. The contract between the two parties contained the following provision: "The work shall be executed under the direction and supervision of the chief engineer of the said canal company, and his assistants, by whose measurements and calculations the quantities and calculations of the several kinds of work performed under the contract shall be determined, and whose determination shall be final and conclusive upon the parties herein." The contractor was to construct the entire canal. He sublet a portion of the work, and the foregoing provision was incorporated in the sub-contract. The sub-contractors finished their part of the work, and received their pay, according to the measurements, estimates and calculations of the chief engineer of the company. But they claimed that these estimates were wrongful and fraudulent, and the work was remeasured, and new estimates made by other engineers, and then they brought suit against the original contractor for the balance they claimed due, in which they were given a judgment. (Annett v. Garland, Supr. Ct., Utah, 30 Pac. Rep., 365.)

Obstruction of Water Course.

Where, in an action for obstructing a water course, the evidence showed that the ditch making the channel of the stream in dispute terminated 10 ft. from a person's land, and the water spread out upon the surface of a meadow below, that person was not guilty of obstructing a water course in placing sods and sticks along the line of his land, to stop the flow of water thereon. (Hawley v. Sheldon. Supr. Ct. of Vermont, 24 At. Rep., 717.)

LETTERS TO THE EDITOR.

COMMERCE AND THE LAKE WATERWAYS.

Sir: At the opening ceremonies of the Chicago-Mississippi Canal, Sept. 3, Mr. L. E. Cooley said:

The lake outflow added nothing to the St. Lawrence Valley, for the needs of commerce in that direction could have been better solved without it.

Will you please state in the next issue of the News how the needs of commerce in that direction could have been better solved without the lake outflow?

Also, in Mr. R. E. Peary's letter published on p. 249 of Engineering News of Sept. 15, are the words "tupic" and "ski." Please explain the meaning of these words, and oblige, Yours respectfully,

A. M. Scripture.

New Hartford, N. Y., Sept. 19, 1892.

(We leave the first conundrum for Mr. Cooley to answer. "Tupic" we presume, means the same as the Indian "Tepee," the tents of skins, etc., which form the usual habitation of nomadic tribes. The "Ski" (or more usually "Skee") is the Norwegian snowshoe. It was fully described and illustrated in our issues of Jan. 18 and March 29, 1890.—Ed.)

MEANING OF "CALL" IN LAND SURVEYING PRACTICE.

Sir: Replying to your note under Legal Decisions, on page 234 of Engineering News of Sept. 8, we would call your attention to definition in Webster's International Dictionary under the word "Call".

(Amer. Land Law). A reference to, or statement of, an object, course, distance, or other matter of description in a survey or grant requiring or calling for a corresponding object, etc., on the land.

This apparently includes the use of the word in the decisions published. In the first one, King v. Mansfield, the question to be decided was one of boundary between two surveys. It was insisted by one of the parties to the suit that "the jury should not have been confined to any one connection unless that connection was called for in the field notes of the survey of which the location was in question." The statement of the court continues, "Survey No. 8 calls for the northwest corner of the W. M. Williams survey. The Williams survey on the south calls for the north boundary line of the Richie survey," etc. And again there was quoted the further contention that if the jury found that the "survey, the true location of which was in question, was located from the northwest corner of the old W. M. Williams, they would ascertain from the testimony the true locality of said Williams survey by calls and connections from the John Richie survey, or any better marked and defined corner around the said Williams survey, originally located, regarding—first, calls for natural objects; secondly, artificial objects; and, thirdly, course and distance." This, the Court said, might be incorrect in that it only permitted the jury to locate the Williams survey from some call other than the Richie survey, when such call was better marked and defined than the Richie. If there was a call as good and as certain as the Richie, the jury should be permitted to construct the Williams survey from such call, although they might be satisfied that it was no better or more certain call than the call for the Richie. Hence the statement reported for the News, "On a question of boundary between two surveys where the evidence as to the location of the calls in the field notes is conflicting, it is not proper to confine the consideration to one connection called for by the field notes, in disregard of evidence of other calls."

In the second case published, Miles v. Sherwood, one of the points insisted on was that "where a survey is made by protracting the lines from established corners on a river front, and not actually measured, and no natural or artificial marks are called for at back corners, the survey should be run from the beginning corner, course and distance only changed so as to run to the last corner on the river, and it is not permissible to reverse the calls running from said last corner, where it would lead to a different result." But the Court denied this, and declared that, "In ascertaining lost lines or corners of surveys, or in defining on the ground such as were never made in fact by the survey, no rule is better recognized than that 'the beginning corner in the plot or certificate of the survey is of no higher dignity nor importance than any other corner; and that reversing the courses is as lawful and persuasive as following the order of the certificate.'"

Yours very respectfully, Law News Bureau.

Chicago, Ill., Sept. 13, 1892.

THE PURDUE UNIVERSITY LOCOMOTIVE ON GRADES.

Sir: I found some time ago, in the Engineering News for May 19, an excellent report of the paper I presented before the American Society of Mechanical Engineers, describing the Purdue experimental locomotive. The reproduction of the drawings was fine, and for a time I scanned the text with satisfaction. But at the close of this most gratifying report I was given a terrible singeing for the statement contained in the last paragraph of my paper, in which severe handling the publication committee comes in for a share, inasmuch as they had admitted the paragraph. The report in question came to me just before the close of our college year, and the demands upon my time were such that for several weeks I had not a moment to give to the matter. Vacation has not offered many opportunities, and I find myself only now ready to shape you a letter on the subject. I hope that the matter has not ceased, through lapse of time, to be of interest.

Your report says, "Prof. Goss closes his paper with the following surprising error concerning the manner of testing the locomotive to represent its work on grades.

"The matter of subjecting the locomotives to conditions similar to those of an inclined track has not been considered as in anyway essential to the present scheme, and no complications have been added to the mounting mechanism with this end in view. It would appear, however, if the point of contact between each driver and its supporting wheel be such as to make their common tangents represent the desired grade, that then the conditions of gradient would be met. The nuts on the drawbar readily allow such an adjustment.

"It is to be hoped that this is not the way in which experimental work with this locomotive will be carried out, for if it is, we may expect to hear announced to the world from the Purdue laboratory that coal consumption is no greater on grades than on a level, or any other like revolutionary statement," etc., etc.

It will be observed that my statement, taken in connection with all that precedes it, is to the effect that the engine as mounted, may be subjected to the conditions of a grade in the same sense that it may be subjected to the conditions of a level track. That this statement is correct, I have no reason to doubt. Its truth can only be demonstrated by exact mathematical processes, but it can, I think, be made to appear from the following considerations. Thus, let A represent one of the locomotive drivers; B, its supporting wheel; w the load on A, due to its own weight and to the weight of the engine; and d the line of action of the drawbar. Also let the couple a b represent the turning moment with which the driver acts; and the couple c e the opposing moment of the supporting wheel; the latter moment being supplied by the frictional resistance of the supporting shaft, and by the brakes which it carries. The center of A is in the same vertical line with the center of B. If, now, A drives B by rolling contact, the effect upon A is the same as though it were rolling along the line of the common tangent T, which in this case is the same as a level rail. If all conditions are constant, the work represented by the couple a b must have its exact equivalent first, in the work absorbed by c e at B, and, secondly, in that represented by the stress in the drawbar. This, so far as I know, has not been called in question; it is mentioned here as an aid in making clear that which is to follow.

Let it now be assumed that the driver is in the position A^1, and that a^1, b^1, is the moment with which it acts. Also let w^1 represent the load on A^1, and d^1 the line of action of the drawbar. In this case it is

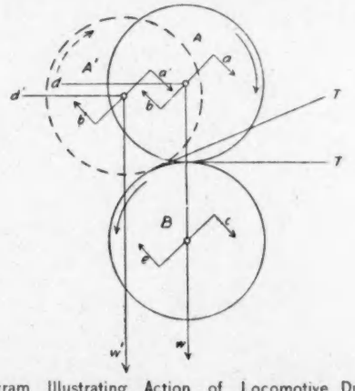


Diagram Illustrating Action of Locomotive Driver Resting on Supporting Wheel.

evident: first, that, as in the previous case, whatever be the value of the couple a^1, b^1, it must be opposed by an equivalent couple, c, e; secondly, that, regardless of drawbar action, power must be given off by A^1 and absorbed by B, in order that A^1 may be maintained in its position against the action of w^1; thirdly, that, if the drawbar stress is to be the same for the position A^1 as for A, the moment a^1, b^1, must be greater than the moment a, b, and the moment c, e, must be correspondingly increased; fourth, that the difference in the power developed in the two cases is due wholly to the change in the position of the driver from A to A^1. But the driver at A acts as upon a level rail, T, and at A^1 as upon inclined rail T^1, which justifies the conclusion that the difference of power required in the two cases is due to the difference in grade. Some correction of drawbar stresses for change in angular position would be necessary, but such corrections would be small.

It is apparent that the thought underlying the criticism was, that since the weight on the driver is not raised, no work can be done against gravity, and if no work is done against gravity, the conditions of grade cannot be met. Such a conclusion is at first sight natural, for it is true that no weight is raised, and no work done against gravity, but it is equally true that, by adjusting the engine as proposed, it will be in a position to require of the friction brakes an amount of work in excess of that represented by stress in the drawbar equal to that necessary to raise the weight over the grade. The action is precisely analogous to that of the well known Prony brake. The weight in such a brake is not raised, but it is sustained against gravity. The work is not against gravity, but by rubbing friction. The measure of the work, however, is that necessary to raise the weight against gravity

through a distance equal to that through which it would pass if it were to turn with the wheel. In the case in question, w^1 corresponds to the weight of the Prony brake. It is not raised, but it is sustained against gravity by rubbing friction, supplied by the brakes connected with B. The measure of the work done by the brakes in sustaining w^1 is equal to that which would be done if the weight were raised along the incline T^1. In what has been said I have assumed an up-grade movement; the principle, of course, will hold for a down-grade movement as well.

Hoping that these suggestions will serve to remove the objection that has been made to the paragraph quoted, as given above, I am Respectfully.

Wm. F. M. Goss.

(It has sometimes seemed to us that the very sensible definition of mathematics, "An aid to correct reasoning," might with some propriety be changed to read: "Mathematics is a hindrance to correct reasoning." Prof. Goss' mathematical proof that the drawbar pull will vary with the position of the engine on the supporting wheels is correct enough. We alluded in our original criticism to "a grain of truth" in his statement that the conditions of gradient would be met when the tangents between the driver and the supporting wheel represented the desired grade. Our criticism is that this is not a good or correct method of imitating the conditions of actual practice, even for class instruction. It is to be remembered that all the work done by this experimental locomotive is absorbed by the supporting wheels, no matter what its position upon them. The drawbar pull simply measures the work which is being done; and of course when the locomotive's weight is on one side of the supporting wheel it exerts a horizontal force which must be added to or subtracted from the pull on the drawbar to ascertain the actual work which is being done. Our contention is, that nothing is gained by this change of position to the locomotive, and that it is misleading. The "conditions of gradient" are, first, an increased load on the engine, and, secondly, an increased exertion of power. Hence, to imitate them it is only necessary, first, to load the dynamometer to a point which will represent the resistance of the hypothetical train on the hypothetical grade and, secondly, to move throttle and reverse lever to such a point that the engine will run at the desired speed. The dynamometer will then truthfully measure all the work which is being done by the locomotive. If for any reason it is desired to deduct the resistance of the locomotive alone, due to the grade, it is so simple a matter to compute it (the weight and the rate of grade being known) that any student who could understand the effect of moving the locomotive backward or forward on the supporting wheels could make the computation instantly.

But, in the second place, if the locomotive were moved back as proposed by Prof. Goss, the drawbar pull would not represent the actual pull of the locomotive on a train on the given grade, for the front truck rests on a level rail, so he must compute the grade resistance of this weight in any event, and of the weight of the tender as well, if he desires to have the dynamometer indicate the actual work done behind the tender on a given grade. The grade resistance for the whole locomotive might as well, therefore, be computed at once. Space forbids an extended discussion of the further practical reasons why the method under discussion is unwise. We may point out, however, that a movevent forward or backward, on the supporting wheels of about ¼ in. on the periphery of a 63-in. wheel will correspond to a change of grade of 1%. Necessarily there must be a greater stretch in the fastenings of the locomotive when working at its full power than when working at a moderate rate, and it is apparent that a very slight movement from this cause (which might even be periodic with the strokes) would materially alter the rate of grade on which the engine was working, and hence the pull on the drawbar.—Ed.)

CRUSHING STRENGTH, ELASTIC LIMIT, ETC., OF BRITISH BUILDING STONES.*

Very few systematic tests of the various properties of British building-stones have been published since the report of the Royal Commission of 1839 was issued. That commission was appointed to inquire into the question of "the selection of stone for building the new Houses of Parliament"; it issued a very valuable report on the stones then chiefly in use, and the results of the experiments they carried out have formed the standard of reference up to the present day. It is a well known fact, however, that the qualities of the stone from any particular quarry are by no means constant. As many new quarries have since been opened, also, it seemed that the time had come for a new series of experiments.

The author determined to carry out tests on the following properties: Crushing strength, density, absorptive power as a test of weathering, and an inquiry into the behavior of stone under gradually increasing pressures with a view to determining the modulus or coefficient of elasticity.

The author put himself in communication with a large number of quarry owners throughout the country, with the object of obtaining specimens, and met with a very cordial response. Naturally, only a selection could be made of all the quarries now worked, but he endeavored to obtain as representative a collection as possible. Three specimens of each stone were asked for, in the form of 2½-in. cubes, as such a cube of the stronger granites was the maximum size which could be crushed in a testing machine of 100,000 lbs. capacity.

The building stones in ordinary use may be classed as granites, limestones, dolomites and sandstones. As far as possible, specimens of these classes were obtained from each district where they occur. Appendix A (omitted) gives a list of the quarries supplying stones, and the districts where they are situated, together with a few notes as to their use.

After the specimens were received they were allowed to remain for some time exposed to the dry, warm air of the laboratory, till practically all the natural quarry water had been evaporated, and it was in this condition that all the measurements and experiments were made. The general plan adopted was to test one of the three specimens at once for crushing strength; to use a second for density, absorption, etc., experiments and then to crush it; and to employ the third for elastic tests before crushing it.

Crushing Tests.—These tests were carried out in the large Greenwood & Batley testing machine belonging to the laboratory of University College, London; a horizontal machine of 100,000 lbs. capacity. The testing machine was described by Professor Kennedy, F. R. S., in his paper on "Engineering Laboratories."* In all cases the load was applied gradually up to the maximum point.

thus prepared were applied directly to the steel faces of the dies of the testing machine, nothing whatever being interposed. This is a point of very considerable importance in the testing of stone and similar materials, and it appears to the author that many of the very discrepant and anomalous results so often obtained in such tests may be easily explained by consideration of the methods adopted for holding the specimens in the testing machine. It has been a common practice to interpose between the specimen and the dies of the machine sheets of lead or thin pieces of soft wood, with the idea that this would secure a perfectly uniform pressure all over the cube, in consequence of the softer lead or wood yielding and thus accommodating itself to inequalities in the pressure from want of parallelism or roughness in the two faces of the cube. It is, however, quite certain, whether the above result is obtained or not, that the introduction of the lead or wood very largely reduces the crushing strength

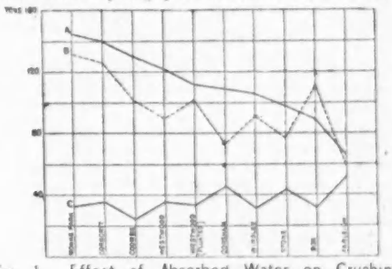


Fig. 1. Effect of Absorbed Water on Crushing Strength of Bath Stone.

A, Crushing strength. B, Ditto, after immersion in water for seven days and redrying. C, Percentage of water absorbed.

of the specimen, and the reason is not far to seek. The compressive forces produce lateral dilatation, and consequently a tension at right-angles to the line of pressure; now under the great pressure necessary the lead flows laterally, and the friction thus caused between it and the face of the cube sets up a very considerable tensile stress additional to the one mentioned above, the result being that the cube is torn asunder into a series of prisms parallel to the axis of pressure by this augmented lateral tensile stress, and the fracture is quite unlike the typical one of stone or such

Fig. 2a. Polmaise Sandstone.

Fig. 2b. Portland Stone.

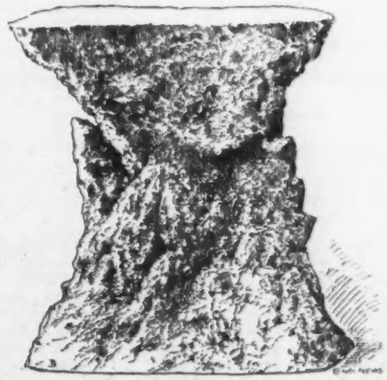


Fig. 3a. Bath Stone.

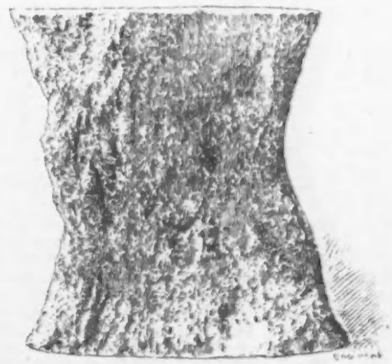


Fig 3b. Ham Hill Stone.

The specimens were carefully prepared at the quarries, so as to insure parallelism of the two sides subspecial request the specimens were placed in the machine i nsuch a way that the axis of pressure was perpendicular to the planes of the quarry bedding.

The faces of the cube to which the pressure was applied (in addition to the careful quarry preparation) were strickled over in the laboratory with a thin layer of plaster of Paris; when this was dry, it was easily rubbed and pared to a smooth surface, and to perfect parallelism of the two pressure faces. The surfaces

material when crushed in the form of cubes. The author investigated this point, and determined the resultant loss of strength in using such interposed sheets of lead, etc., by a series of comparative tests, the results of which are given in the subjoined table.

The enormous reduction of strength, varying from 36 to 55%, is very apparent, and the fact that the loss is greater the stronger the stone points very clearly to its origin, viz., the lateral flow of the lead under the great pressure to which it was subjected. The use of thin pieces of soft pine is still more destructive. Three specimens of Corncockle were tested; two with

* A paper by Thomas Hudson Beare, Assoc. M. Inst. C. E. condensed from Proc. Inst. C. E.

* Proc. Inst. C. E., vol. lxxxviii. p. 1.

lead interposed had a mean strength of 195.1 tons per square foot, while one with pine carried only 145.4 tons before breaking up into a number of prisms.*

The author is therefore of opinion, that, for the sake of obtaining accurate and uniform results, stone cubes should always be prepared and tested in the way adopted in these experiments; in a few cases he inter-

Influence of Interposed Lead Sheets on the Strength of Stone Cubes.

Name of stone:	No. cubes.	Method of bedding.	Crushing strength. Tons per sq. foot.	Loss of strength by use of lead. Ton per sq. foot.	P.c.
Binnie	1	Lead ⅛ in. thick.	253.4	154.1	37.8
"	2	Plaster of Paris.	407.5		
Hermand	1	Lead ⅛ in. thick.	253.4	130.7	35.5
"	2	Plaster of Paris.	393.1		
White hailes	1	Lead ⅛ in. thick.	298.1	309.3	55.3
"	2	Plaster of Paris.	607.4		
Arbroath	3	Lead ⅛ in. thick.	321.1	237.0	42.5
"	3	Plaster of Paris.	558.1		
Craigleith	3	Lead ⅛ in. thick.	408.9	453.0	52.6
"	3	Plaster of Paris.	861.9		

Note.—For the first three stones the cubes were all cut from one block. This was not the case for Arbroath or Craigleith, the second sets being obtained at a later date.

posed between the die and the plaster of Paris face millboard (which is practically incompressible at the pressures used), but it did no good, and if anything, harm. There is no necessity for anything, except the thin layer of plaster of Paris, which, to all intents and purposes, becomes part of the stone cube.

These interesting results emphasize also very clearly the effects of bad bedding in structures in reducing the strength of the stones used.

One cube, or in some cases two cubes, were, after drying in the laboratory, tested at once to destruction. There may be recognized in the appended tables, in which all the results are given, by the absence of any figures in the columns for the other tests. It so happened that the first stones tested were Bath and other oolitic limestones, and the author found that there was apparently some reduction of strength caused by the immersion in water and subsequent redrying; he, therefore, as far as this class of stones was concerned, abandoned this plan, and tested two samples of each set at once to destruction, reserving the third as before for elastic work. For the absorption tests two other cubes of each stone were obtained from the quarries and eventually crushed. No such effect was found in the case of the sandstones, dolomites, or granites, and with them, therefore, the original plan was adhered to. Whether there really was a loss of strength is not quite certain; the curves in Fig. 1 show graphically the strengths of the two series of Bath stones, and it will be noticed that the curve indicating the crushing-loads for the immersed and redried cubes does show a distinct tendency to fall below the one for the series which was not placed in water; Fig. 1 also shows by another curve the relative absorptions of the different stones.

In general, there was no preliminary cracking noticeable. Most of the stones gave way quite suddenly, and the type of fracture was that shown in Figs. 2 and 3, which are photo-zincographic reproductions of fractured cubes. Let a cube or other solid be subjected to direct compressive forces, and on any plane section inclined to the axis of pressure; there will be on this plane a normal component and a tangential component of the axial pressure. The latter will tend to produce shearing strain on this plane, and were it the only internal force present it can easily be proved that it would reach its maximum value on planes inclined at 45° to the axis; but there can be no doubt that the normal component interferes with this by producing a resistance to the rubbing of the two surfaces over one another in the act of shearing. The plane at which shear does take place is therefore often not inclined at 45° to the axis; furthermore, the lateral dilatation before mentioned effects the result, causing the sides often to break off into prisms.

Were the maximum shear to occur on planes at 45° to the axis then the cube would tend to break up into six pyramids with their apices at the center. Generally the two corresponding to the top and bottom faces (i. e. the ones in contact with the dies) remained intact, and could be removed from the machine; but the others usually crumbled into irregular pieces or dust. In several cases, however—notably the oolites—the side pyramids also remained unbroken, the fracture being quite perfect.

In the tables, the stones are grouped under the four heads of sandstones, dolomites, limestones, and granites, and also largely in districts. It will be seen that the figures for crushing-loads are very closely concordant, and largely they speak for themselves. The mean crushing-strength for each class may, however, be useful. It was as follows:

Mean of crushing strength.

Varieties.	Samples.	Tons per sq. ft.	Lbs. per sq. in.
Granites	13	49	1,122.2	17,500
Oolites*	18	57	141.3	2,200
Sandstones	25	88	480.8	7,620
Dolomites	4	16	500.5	7,800

* This mean does not include limestones which are not oolitic, and does not include the immersed and redried oolites.

As a rule, the results are higher than in the older experiments, and agree better with each other. In the case of Bath stones, two means have been give: the one in brackets is for the cubes of each set, which were not immersed in water, while the other includes them all. Every test which was made is included in the tables.

Density.—Each cube was accurately measured to obtain its exact cubical contents, and carefully weighed; then this weight was compared with the known weight of an equal volume of water at the standard temperature. The very close agreement of the results where two or more cubes of one kind of stone were tested is sufficient proof of the carefulness and accuracy of these results. In the case of the granites, since the absorption of water is exceedingly small, the specific gravity or density was also determined by weighing the cube in air, and then in water; this method also gave very close results, and in strict agreement with those obtained by the other plan. The weight per cubic foot has been calculated from these density results, assuming 1 cu. ft. of water to weigh 62.42 lbs.; the mean density is used for the calculation where there are several results.

Absorption of Water.—For this test, the cube, after it had been measured and weighed as above described, was lowered gradually into a vessel of water (earthenware crocks were used), and left there for a period of six or seven days. Saturation probably occurs within a very few hours, but it is safer to leave the cube under water for some days. At the end of this time the stones were removed, wiped with a dry cloth to remove adherent water, and at once reweighed. The gain of weight compared with the figures for the dry stone is that due to the water absorbed. In column 7 of the tables, the results are expressed as a percentage of the original weight, by dividing the gain by the dry weight. It may be mentioned that every care was taken to have the stones thoroughly dry before beginning these tests, and they were allowed to again dry before crushing them. The water used for a few of the earlier specimens was drawn from the College service-supply, but for all the others, pure distilled water was used.

That there was some dissolving action going on in the case of the oolites was shown by the condition of the water in the vessels after the stones were removed; it was slightly cloudy, and there was a distinct sediment. This is quite sufficient, probably, to account for any apparent loss of strength.

Of course, to be at all comparative, absorption tests must be made on cubes of the same size, so that the surfaces exposed to the water may bear the same relation to the volume of the cube. It is, therefore, not easy to compare one set of observations with another; in this case they are strictly comparable, as all the cubes were of the same size, and treated in precisely similar fashion. The relative amounts of absorbed water must be a very good guide to the relative weathering power of stones, since it shows to what extent deleterious agents in rain water and fogs will penetrate the stone, and, furthermore, a freely absorbent stone must be very liable to the destructive action of frost. Summarizing again, in order of absorption, oolites (average of 27 samples), absorb 8.06% of their dry weight; dolomites (average of 4 samples), 5.43%; sandstones (average of 26 samples), 4.68%; granites (14 samples), 0.27%.

Fig. 1 shows diagrammatically for Bath stones the relation between absorption and strength to resist crushing, and also the apparent resultant loss of strength. There are two sets of cubes of Westwood Ground, one set having been treated by Mr. Kessler's process for hardening and preserving calcareous stones. The effect of its application seems to be a slight reduction in strength, with also a slight lowering in the quantity of water absorbed. The process is largely used in France, and seems to be very successful in reducing and checking decay of oolite and other limestones.

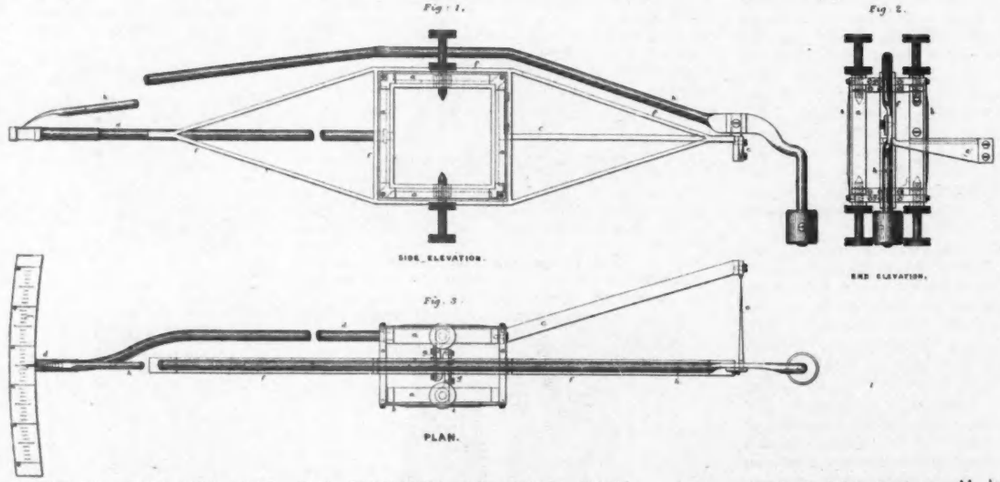


FIG. 4.—APPARATUS FOR MEASURING THE ELASTICITY OF STONE CUBES. Designed by A. G. Ashcroft, Assoc. M. Inst. C. E.

Coefficients of Elasticity.—It is a matter of extreme difficulty to obtain these coefficients for stone. The specimens operated on are necessarily small, and the quantities to be measured very minute. It is a difficult enough matter to obtain thoroughly trustworthy results when dealing with iron and steel, the specimens of which can be made in lengths of 10 ins. and upward; when dealing with only 2½ in. cubes, it becomes impossible to use any ordinary strain-measuring apparatus. The author, therefore, requested his assistant, Mr. A. G. Ashcroft, Assoc. M. Inst. C. E., to undertake the devising of a measuring gear, for use with these small cubes, capable of magnifying about 2,500 times. The essentials were, the gear must be very sensitive and free from all inertia and resultant backlash. After several trials, the apparatus shown in Fig. 4 was elaborated, and was finally used in all these tests.

The principle on which the gear is arranged is to obtain the needful magnification by a system of levers, that is, by mechanical exaggeration, and not by optical means. A brass frame, a, embraces the cube, and is attached to it at the top and bottom by two pairs of set

* This point is noticed in Stillman's "American Journal of Science and Arts," vol. xxii., pp. 30-38. Also in Unwin, "The Testing of the Materials of Construction."

screws; the centers of these pairs are exactly 1½ ins. apart; this forms the length on which the compressions are measured. The brass frame a is made in two pieces, each piece being a square frame with two uprights at opposite ends of one diagonal, thus the two pieces when placed together form a hollow prismatic frame; the two parts are secured together and united, with freedom to move relatively to one another, by eight spring pieces, b. One of the two sides of a supports on one side an arm c, and on the other a long arm d, with a scale attached to it; the arm c carries at its end at right angles to itself a small piece of steel e, the attachment being a spring one,; on the end of e is a center dot. Surrounding the frame a is a cross frame f, which is made double for balancing purposes; this cross frame is attached by spring pieces of the "Emery" type (which take the place of knife edges),

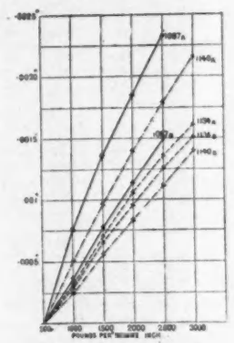


Fig. 5. Sandstone.

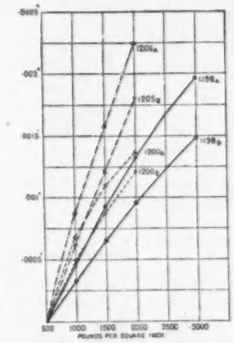


Fig. 6. Sandstone.

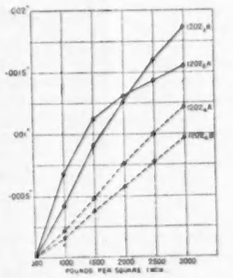


Fig. 7. Sandstone.

1087$_3$ Prudham ... { A. First test. B. Second test.
1134$_3$ White Plean { A. First test. B. Second test.
1140$_3$ Dean Forrest { A. First test. B. Second test.

1198$_3$ Darley Top { A. First test. B. Second test.
1200$_3$ Bramley Fall { A. First test. B. Second test.
1205$_3$ Aspatria .... { A. First test. B. Second test.

1202$_3$ Lightcliffe Bed$_4$ { A. First test. B. Second test. Plane of pressure parallel to bedding.
1102$_4$ Lightcliffe Bed$_4$ { A. First test. B. Second test. plane o pressure perpendicular to b'd'g

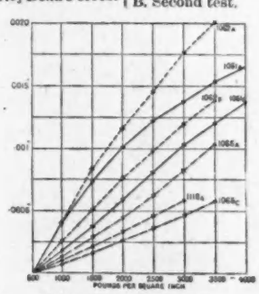


Fig. 8. Dolomites.

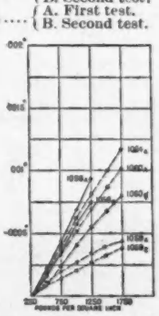


Fig. 9. Limestones.

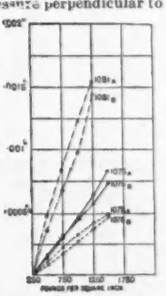


Fig. 10. Bathstones.

1061$_3$ White Mansfield..... { A. First test. C. Third test.
1062$_3$ Red Mansfield { A. First test. F. Sixth test.
1065$_3$ Brown Weather Bed..... { A. First test. C. Third test.
1118$_3$ Yellow Magnesian Limestone..... { A. First test.

1058$_3$ Doulting Fine Bed..... { A. First test. B. Second test.
1059$_3$ Doulting Chelynch Bed.. { B. Second test. C. Third test.
1060$_3$ Ham Hill..... { A. First test. B. Second test.
1064$_3$ Ancaster Freestone..... { A. First test.

1075$_1$ Monks Park.. { A. First test. B. Second test.
1078$_1$ Corngrit... { A. First test. B. Second test.
1081$_1$ Westwood Ground.. { A. First test. B. Second test.

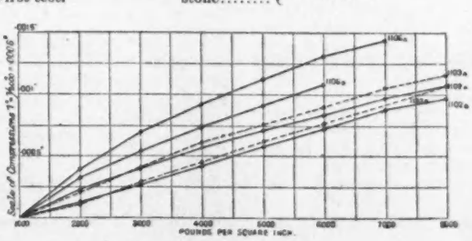


Fig. 11. Granite.

1102$_2$ Aberdeenshire, Peterhead..... { A. First test. B. Second test.
1103$_2$ Aberdeenshire, Dyce..... { A. First test. B. Second test.
1106$_2$ Aberdeenshire, Hill of Fare.... { A. First test. B. Second test.

g, to each of the two halves of a; on the end of this cross frame, close to the piece e, is another center dot. Any compression of the stone cube will cause the cross frame to move relatively to the arm c, and the distance apart of the two "Emery" springs being 0.3 in., while the horizontal length of c is 7 ins., there is a resultant exaggeration of the cube's compression, at the center dots, of about 23-fold. Resting by means of needles in the two center dots is a pointer h, whose length is 100 times the distance between the two needles; the end of the pointer as it moves over the scale has, therefore, a motion 100 times as great as that of the center dots relatively to one another, or magnifies between 2,300 and 2,400 times the compression of the cube. By the system of springs used throughout in the construction, and the lightness of all the parts, the author believes that all backlash has been eliminated, and the gear is extremely sensitive; it also accommodates itself to any inequalities in the pressure. The actual magnification was determined by testing it against the laboratory standard gear on a piece of cast iron prepared for the purpose. It proved to be 2,358 times. This calibration gave also an opportunity of testing its delicacy and accuracy before using it with the stone cubes.

The method of carrying out the tests was as follows: A load was applied sufficient to keep the specimen with the gear attached in its position in the machine between the ties, and the corresponding scale reading was taken as zero; this load varied from 250 lbs. to 1,000 lbs. per sq. in. This plan was adopted to prevent any possibility of derangement of the gear by shocks, in putting on and off the load, such as might occur if the pressure had been entirely removed, and it was easy to let back the load to these amounts when taking sets. The loads were then increased gradually by 250 lbs., 500 lbs., or 1,000 lbs. per sq. in., at a time, according to the strength of the stone, and each time readings of the position of the pointer on the scale taken, till the highest load it was desired to apply was reached; the load was then let back to the starting load, and the permanent set measured. A fresh set of observations was then made with this new zero, the same method of procedure being followed. In a few cases still further series of readings were made; but as in most cases, the additional permanent set produced by the second application of the load was extremely small, these additional series were not made unless something anomalous had occurred.

The results are given in columns 8, 9 and 10. The co

Crushing Strengths, Absorption, Density, Co-efficients of Elasticity, Etc., of Building Stones.

Condensed from Tables of Thos. Hudson Beare.

No.	Name of stone.	Mean crushing load, per sq. ft., tons.	Mean weight, 1 cu. ft., lbs.	Absorption. Per cent. dry weight.	Co-efficient of elasticity for pressure. First time load applied. Tons per sq. ft.	Co-efficient of elasticity for pressure. Reapplicat'n l'd. Tons per sq. ft.
			Sandstones.			
4.	Prudham.....	455.3	142.5	4.00	78,200	125,300
4.	"	455.3	142.5	4.32	91,960	109,200
3.	Corncockle....	383.8	132.6	4.57	138,700	156,500
3.	Gunnerton....	354.6	130.8	5.16	109,400	111,950
3.	Cragg.....	573.8	136.1	4.13	124,800	153,300
8.	Corsehill.....	444.9	130.4	7.94	101,600	121,000
5.	Polmaise.....	551.5	141.7	4.58	119,600	138,100
3.	White Plean...	612.8	138.2	4.25	146,000	157,400
3.	Arbroath.....	558.1	151.0	2.32	134,000	164,800
3.	Auchinlee.....	203.6	128.9	6.90	62,900	84,080
3.	Craigleith.....	861.9	138.6	3.61	.....	.....
3.	White Hailes..	662.0	143.8	3.71	78,780	105,100
3.	Dean Forest..	530.0	151.4	2.71	113,600	172,000
3.	Gatelawbridge.	495.7	129.5	5.84	143,000	168,100
4.	Blue Hailes....	459.7	143.2	4.70	54,290	86,060
3.	Binnie.....	569.1	135.1	5.22	124,200	152,300
3.	Hermand.....	457.4	142.6	4.70	150,100	191,900
3.	Howley Park..	466.7	140.3	4.90	83,700	116,500
3.	White Grimshill	209.3	122.5	7.80	101,000	115,500
3.	Darley Top....	516.7	139.0	3.40	120,200	160,200
3.	Hercules Ridge	335.7	138.0	3.60	154,200	171,200
3.	Bramley Fall..	238.4	132.2	3.70	106,800	114,900
3.	Ackworth.....	389.1	140.7	5.00	61,960	90,960
3.	Robin Hood...	574.0	144.6	3.90	127,200	132,200
3.	Aspatria.....	233.9	123.2	8.50	64,980	80,100
4.	Lightcliffe....	1,020.5	149.6	2.30	191,600	241,400(f)
			Dolomites.			
4.	White Mansfield..	461.7	140.1	5.01	209,800	235,600(d)
4.	Red Mansfield..	501.9	143.2	4.58	137,100	198,700(e)
5.	Yellow magnesian limestone..	577.4	145.4	4.62	406,100	.....
3.	Anston.....	301.9	132.2	7.50	229,800	350,000
			Limestones.			
4.	Ancaster.....	552.6	156.3	2.42	289,700	499,800
3.	Portland base bed..	287.0	137.6	6.84	.....	.....
3.	Portland base bed...	146.8	124.5	11.10	.....	.....
3.	Portland white bed..	204.7	132.3	7.51	236,900	.....
3.	Ketton.....	101.7	127.9	8.10	141,300	156,900
3.	Limestone (crystalline)..	956.2	174.7	....	.....	.....
2.	Corsham Down	109.5	131.6	.....	61,980	116,000
3.	" "	94.5	127.6	11.12	72,400	.....
5.	Farleigh Down..	62.5	120.5	12.64	147,000	166,100
5.	Monks Park...	139.6	136.7	7.74	.....	.....
5.	Box ground...	97.5	127.9	8.10	138,700	129,200
5.	Coombe Down.	117.7	128.6	6.19	.....	.....
5.	Corngrit.....	134.5	133.6	8.72	109,300	.....
5.	Stoke ground..	90.0	126.3	11.14	164,000	.....
5.	Winsley ground	100.7	132.9	7.74	164,000	.....
5.	Westwood gr'd	110.2	130.3	9.12	62,300	128,900
5.	Westwood gr'd (flated).....	111.5	132.3	8.46	.....	.....
		106.9	.....	7.61	.....	.....
5.	Doulting fine beds.....	111.6	125.0	10.70	97,580	121,000
		103.9	.....	11.05	.....	.....
5.	Doulting Chelynch beds....	180.8	150.4	3.42	357,600(c)	379,000
		.....	.....	3.30	.....	.....
3.	Ham Hill.....	166.3	136.0	.....	140,000	164,500
4.	Ancaster freestone.....	184.0	140.4	6.27	120,100(b)	130,500
			Granites.			
5.	West of England Penzhyn....1,060.2		165.4	0.12	.....	.....
3.	Cornish Grey.	955.9	161.7	....	463,500	538,900
2.	Aberdeenshire	1,234.3	162.9	0.38	.....	.....
3.	Corennie.....1,318.3		159.1	0.42	523,600	540,700
3.	Aberdeenshire. Cove.....	987.1	169.1	0.55	.....	.....
3.	Aberdeenshire. Kemnay....1,088.5		164.1	0.42	.....	.....
		1,211.1	161.0	0.21	.....	.....
3.	Aberdeenshire. Craigton....1,282.0		.....	....	.....	.....
3.	Aberdeenshire. Peterhead..1,207.7		158.5	0.29	644,000	657,000
3.	Aberdeenshire. Dyce.....1,105.8		165.4	0.19	587,000	621,400
3.	Aberdeenshire. Hill of Fare.	1,360.3	160.4	0.40	.....	.....
		.....	157.9	....	381,000	460,400
3.	Aberdeenshire. Sclattie....	850.5	161.0	0.10	266,000	321,700
3.	Aberdeenshire. Persley grey	942.8	162.3	0.19	522,300	.....
3.	Aberdeenshire. Rubislaw...1,098.8		163.7	....	445,000	525,200
3 (a).	.....	1,289.7	.....	....	.....	.....
3.	Ben Cruachan...	876.9	171.6	0.29	.....	.....

Note.—1 ton (of 2,240 lbs. per sq. ft.)=15.56 lbs. per sq. in., whence a modulus of 100,000 tons per sq. ft.=1,556,000 lbs. per sq. in.

(a) Obtained from rock 177 ft. beneath the surface.
(b) Second application of load.
(d) Third application of load.
(e) Sixth application of load.
(f) Another sample showing almost identical qualities otherwise, had a coefficient of only 127,800 tons on reapplication of load Result of first application not recorded.

efficient again illustrates the effect of the more compact arrangement due to the natural crystalline character. rangement due to the natural crystalline character.

The mean for the limestones (omitting 1,059), are 133,530 and 150,750 tons per sq. ft.; they are thus for the first test of nearly the same value as those for the sandstones in the state of ease.

The granites are illustrated in Fig. 11. The range of stress is, of course, much greater, but they also exhibit the above characteristics. Much less set was produced by the first loading; this is seen by the closer approximation of the two values of the coefficient of elasticity. The value of the coefficient is for the first test 479,000, and for the other test 522,100 tons per sq. ft., or in lbs. per sq. in., 7,450,000 and 8,121,000, respectively, about a quarter of the corresponding values for steel.

The author believes these figures will be of considerable interest and importance when the design of structures is being dealt with, where great weights have to be carried on foundations or by piers and columns, and as also affording data for calculating the stresses thrown upon masses of masonry by expansion and contraction due to changes of temperature. It had originally been intended to also deal with these constants by means of transverse tests, and to extend the inquiry into the transverse strength of some of the leading stones. Pressure of work has necessitated the postponement of this and a few other points, but it is proposed to undertake the inquiry very shortly. Enough has been done to show the value, necessity, and importance of systematic tests of stone when being used in large works. Engineers, who would never dream of employing iron and steel without careful tests, accept large quantities of stone without any form of test, trusting merely to a casual examination. Although stone is not subject to the imperfections and carelessness of manufacturing processes, still, like all natural substances, it varies greatly in quality, and hence the need of tests is just as great as in the case of manufactured articles.

The preceding table is very considerably abridged from the table which concludes the paper in the Proceedings Inst. C. E. in the following respects:

1. In omitting all record of the laboratory numbers.

2. In omitting all records of the separate tests for crushing load, but only giving the mean.

3. In omitting all record of the separate tests for density, but only giving the average. As a rule, as might be expected, the specimens having only a little greater density showed a very marked increase in crushing strength. For example, the eight specimens tested of Prudham sandstone (the first in the table) compared as follows:

Mean crushing load: tons per sq. ft.	473.8	393.8	517.3	451.2	454.2	408.5	472.4	468.2
Density (for those stones whose density was taken):	.....	2.27	2.30	.....	.....	.....	2.31	2.25

4. In omitting the column of range of stones in the elasticity tests. As the accompanying diagrams show the stones displayed substantially the same laws (though not the same coefficients by any means) as metals do. The usual range of the sandstone dolomite and limestone tests was from 32 to 192 tons per sq. in., though some, lacking sufficient crushing strength, were only tested up to 128 tons, or even 64 tons. The first dolomite given was tested for elasticity up to 257 tons. The granites were mostly tested from 64 up to 514 tons, though the first and fourth above the last were tested only to 386 tons, and the third above the last to 257 tons only.

It will be seen that the granites have a very high modulus of elasticity, averaging about one-fourth that of steel. The sandstones were from 15 to 20 times as compressible as steel, or 4 or 5 times as compressible as granite. The fact that the modulus is so increased after the first test is a curious one, never before observed to our knowledge, though fairly inferable from the behavior of metals.

A CHICAGO GRADE CROSSING.

The problem of the improvement of the railway terminal systems of Chicago is rendered particularly difficult of solution by the confused and intricate crossings and interlacing of the tracks of different companies at several points. These grade crossings are a serious hindrance and danger to both railway and street traffic, as we have several times pointed out in our articles on the Chicago terminals. To rearrange these tracks and place them on an elevated structure would be an enormously expensive work, but, as pointed out in an abstract of the report of the Terminal Commission (Eng. News, July 21, 1892), it is recommended that all tracks entering the city should be elevated, and that all existing main tracks should be excluded from the district north of 22d st., the main terminals being placed south of that boundary. According to this report there are no less than 1,500 crossings of streets at grade, but the number of combined track and street crossings at grade is not given.

We present herewith a plan of one of the most complicated railway grade crossings we have ever seen, which is what is known as the Stewart Avenue crossing in Chicago, near the intersection of Stewart Ave. and 21 St. This complex crossing has been equipped with signals and interlocking plant by the Union Switch & Signal Co., of Pittsburg, Pa., to which we are indebted for the accompanying plan and particulars of train movements. There are tracks of five different companies crossing and connecting in the most confusing manner in a space of about 1,200 ft. by 600 ft. and the designing of the signal and interlocking system must have been most difficult and unpleasant.

The accompanying plan shows the arrangement of the tracks, and the letters and arrows indicate the tracks of the different companies and the direction of the traffic. The railways are as follows: Pittsburg, Fort Wayne & Chicago Ry., Atchison, Topeka & Santa Fe R. R., Chicago & Alton R. R., Chicago & Western Indiana R. R., Chicago, Madison & Northern branch of the Illinois Central R. R. There are three signal bridges; No. 1 is 66.6 ft. long, No. 2 is 63 ft. 11 ins. long and No. 3 is 99 ft. 6 ins. long.

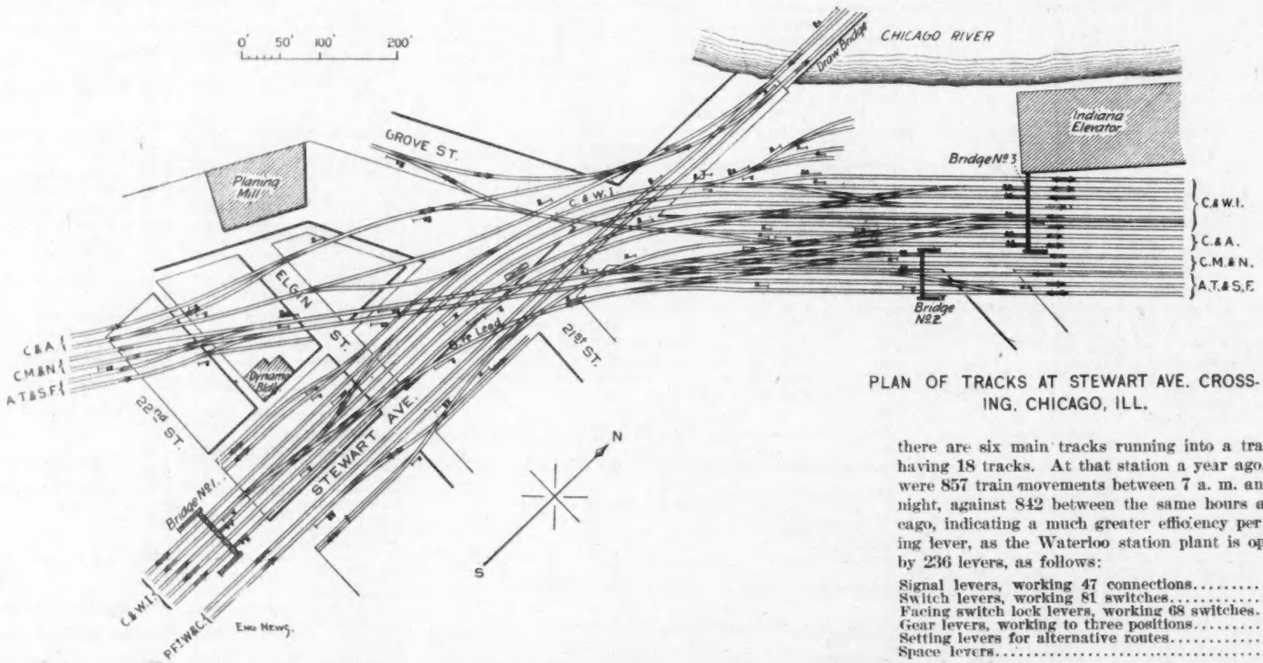
Train Movements at Stewart Ave. Crossing, Chicago.

From 6 a. m. July 18 to 6 a. m. July 19.

	Passenger. Thr'gh.	Passenger. Swit'h.	Freight. Thr'gh.	Freight. Swit'h.	Local Eng's.	Total.
6 to 7 a. m....	15	0	0	6	12	33
7 to 8 a. m....	16	0	0	7	19	42
8 to 9 a. m....	16	6	0	30	12	64
9 to 10 a. m...	13	2	0	30	17	62
10 to 11 a. m..	18	2	0	40	19	79
11 to 12 a. m .	6	2	0	43	9	60
12 to 1 p. m...	6	0	0	28	15	49
1 to 2 p. m....	10	2	0	19	11	42
2 to 3 p. m..	10	0	1	37	15	63
3 to 4 p. m....	8	0	2	59	11	71
4 to 5 p. m,...	14	0	2	41	25	82
5 to 6 p. m....	21	0	0	19	16	56
Total, day.	153	14	5	350	181	703
6 to 7 p. m....	21	0	0	18	20	59
7 to 8 p. m....	10	10	0	12	10	42
8 to 9 p. m....	7	2	0	7	8	24
9 to 10 p. m...	5	0	0	7	4	16
10 to 11 p. m.	4	0	0	7	3	14
11 to 12 p. m.	4	2	0	10	1	17
12 to 1 a. m.	1	0	0	10	0	11
1 to 2 a. m....	0	0	0	12	0	12
2 to 3 a. m....	0	2	0	3	1	6
3 to 4 a. m..	0	0	0	9	2	11
4 to 5 a. m....	0	0	0	30	6	36
5 to 6 a. m....	2	2	0	18	11	33
Total, night	54	18	0	143	66	281
Grand total..	207	32	5	493	247	981

The plant is operated from a single central tower, and comprises 50 working levers, 84 switches, 86 signals, and 22 double slips with movable frogs.

The total number of train movements is nearly 1,000 per 24 hours, and the hourly numbers are shown on the accompanying table. In our issue of June 23, 1892, we described the new interlocking and signal plant at the Waterloo terminal station in London, of the London & Southwestern Ry., where



PLAN OF TRACKS AT STEWART AVE. CROSSING, CHICAGO, ILL.

there are six main tracks running into a trainshed having 18 tracks. At that station a year ago, there were 857 train movements between 7 a. m. and midnight, against 842 between the same hours at Chicago, indicating a much greater efficiency per working lever, as the Waterloo station plant is operated by 236 levers, as follows:

Signal levers, working 47 connections	102
Switch levers, working 81 switches	50
Facing switch lock levers, working 68 switches	46
Gear levers, working to three positions	7
Setting levers for alternative routes	16
Space levers	15
Total number of levers	236

CHICAGO'S NEW FOUR-MILE LAKE TUNNEL AND ITS APPENDAGES.

By Bernhard Feind, M. Am. Soc. C. E.

(Concluded from p. 245.)

Extra Claims for Work on Four-Mile Tunnel.*

The contractor for the tunnel, Mr. Andrew Onderdonk, claimed extras on certain sections of the single 8-ft. and the double 6-ft. tunnel, on the ground that the city misrepresented the character of the soil to bidders. Mr. Onderdonk also claimed extras for timber and lumber built in outside the regular

*This section was added at our special request after the articles which appeared in our issues of Sept. 8 and 15, 1892, were written. Mr. Feind, it may be added, was First Assistant City Engineer during construction, or a greater part of the construction of the tunnel.—Ed.

cross section of the tunnels and not included in the regular estimates. As to the first claim, records of borings were furnished bidders showing the soil to be all clay hardening with increasing depth, while several very troublesome soft and wet strata had to be dealt with as stated in the article which appeared Sept. 8. The specifications state that "the ground is believed to be good clay with occasional pockets of sand and water," but that "the contractor must take the work at his own risk."

As to the second claim, the specifications state that "all excavated space outside of the regular brickwork shall be filled solidly with masonry." But it would have been absurd to attempt such a thing in the soil encountered, and the contractor had to build in a great amount of timber and lumber of all kinds to hold up the cross section during construction.

The specifications state that "all claims for extras must be submitted to the Commissoner of Public Works in writing at the end of each month, and failing to do this the contractor shall forfeit all his claims for extras." Mr. Onderdonk failed to do this. He made efforts, however, to have the price for certain sections of double 6-ft. tunnel definitely adjusted in advance by the Commissioner of Public Works, in which efforts he was not successful, the Commissioner leaving this price for future adjustment.

The amounts claimed for extras are as follows:

21,076.42 lin. ft. of single 6 ft. tunnel, at $12 additional	$252,917
7,237.8 lin. ft. of single 8-ft. tunnel at $10.50 additional	75,986
784 M. ft. B. M. timber and lumber at $43.	33,712
Total	$362,615

The amounts of the awards were:

21,047 lin. ft. of single 6-ft. tunnel at $4 additional	$ 84,188
7,236 lin. ft. of single 8-ft. tunnel at $7.50 additional	54,270
500 M. ft. B. M. timber and lumber at $20	10,000
Total	$148,458

The award was made (I now extract from the Chicago "Tribune") partly on the basis of evidence given by the experts, who were Gen. Wm. Sooy Smith, General FitzSimons and the writer. The average of the estimates of these three experts of the excess of the proper price for tunnels in soil like that which was actually encountered (or, in other words, of the excess of the probable lowest bid under the assumption that the bidders were familiar with the true condition of the soil), over the price actually paid by the city, was cut in two by the board of arbitration and one-half of this excess was awarded the contractor as additional price.

The amount awarded for timber and lumber built in was based on statements furnished by the writer, which Mr. Onderdonk accepted at once.

The board of arbitration consisted of a number of aldermen, members of the Finance Committee of the City Council. The findings of this board are final, by previous agreement between Mr. Onderdonk and the city.

ELECTRICAL MEASURING INSTRUMENTS.

(Continued from page 259.)

Electric meters may be divided into several classes: The chemical, or electrolysis, meter is largely used in America for direct current work. A low resistance is inserted in the main circuit, and a high resistance in shunt to it. In the high resistance circuit a voltameter is inserted. Mr. Edison uses zinc in zinc sulphate for his voltameter, and appears to get very good results. If amalgamated zinc is used, an electromotive force of a millionth of a volt on the voltameter is enough to work such a meter; there should be no error if the zinc sulphate solution is used diluted so that it remains homogeneous, and if the plates are well amalgamated. This meter is not used in this country. It has only one drawback, and that is that the deposits have to be weighed. On the other hand, it has the advantage of cheapness in manufacture, and is not apt to get out of order. It is then a question whether the trouble of weighing is not more than paid for by the gain in first cost. If the meter costs $25 less than one with an index, the interest on the saved money, taken at 7½%, is $1.87 a year. If the inspector calls once a quarter it will pay to use this form, if the weighing takes up less than 45 cts. worth of his time. It is not at all likely his time would be so valuable as this. There is, however, a great prejudice against such meters.

For alternating currents aluminum may come into use. This is the only metal which cannot be deposited electrolytically, so that the quantity of electricity passed can be found from the loss of both plates. It is difficult, however, to obtain aluminum quite free from silicon and other impurities, and the plates are apt to dissolve slowly even when there is no current. Mr. Wright has used copper voltameters in series with high resistances as meters in series distribution. Such a meter really integrates the pressure, and, as the current is constant, the energy taken is readily found.

The largest class of meters depend on small motors. The motor is generally arranged to do work on a brake. The brake usually employed is an Arago disk, or some sort of fluid friction arrangement, such as a fan in air or in a liquid, as for example mercury. The meter may be coupled up in many ways; the armature and the field magnets may be in the main circuit, or may be in shunt circuits across the pressure terminals of the house and so on, or permanent magnets may be used for the field. Alternating-current meters again demand special motors. The meter may have a number of armature turns and a commutator, or it may be of the one turn type, which demands no commutator. To make a meter accurate there must be a law underlying it. If a voltmeter does not give a straight line law, the scale is graduated to read correctly; it would be hopeless to take such a voltmeter as most of the soft iron instruments described, and to tamper with the shapes of the parts until a straight line law was obtained; and no one who had experience in instrument manufacture would have confidence in the result. In fact each of the instruments would have to be manipulated individually. In practical work, therefore, when accuracy is required, the scale is altered to fit the instrument. In a meter this cannot be done. It must be made to give a straight line law; or in other words, a meter must be based on laws in accordance with which it moves its train at a speed proportionate to the current or power as the case may be. It must not follow some other law and be manipulated till it gives readings which may be nearly right, but are probably still very wide of the truth.

Motor meters with the field in series with the armature, work under disadvantage. The brake in this case is generally fluid friction. There is some doubt as to what law fluid friction follows. It is at times said that the force varies as the speed, and at others that it varies as the square of the speed. According to one theory the force varies as the speed as long as that is small. When the speed reaches a certain value vortices are produced, and the force varies as the square of the speed. A series meter is correct only when the torque varies as the square of the speed, and the power as the cube; at low readings it will be against the supply company. If the torque is the sum of two torques, one of which varies as the speed and the other as the square of the speed, the meter will work correctly if its field has shunt-and-series windings in the proper proportions. Some series meters are arranged with shunts, but the object is generally understood to be to overcome the difficulty of starting. In addition to the fluid friction, there are the frictions of the pivots, and of the film of oxide on the surface of the mercury, when that has to be overcome. A series meter has only one ten-thousandth part of its full load torque available at 1% of the full load. The shunt series arrangement has a much greater torque. The whole question of fluid friction in meters demands investigation. Some fluid friction meters are series wound, some have constant and some compound fields. They cannot all be right. There is still another objection to series and compound fields for direct current work, and that is that errors arise through hysteresis. If the meter has been reading at full load, and the load is greatly reduced, it will read too high. The Arago disk and all other arrangements involving Foucault currents take torques proportional to the speed, and power proportional to the square of the speed; not torque proportional to the square of the speed and power proportional to the cube, or to the speed. This point is of great importance in the theory of meters, more especially as it is frequently incorrectly stated. Even the French Commission, when they awarded the prize of 10,000 fr., were inaccurate on this point. The difficulty of starting at small loads occurs in all meters following square laws. If, for instance, 100 amperes yield torque which affords a reasonable speed for the full load of the meter, then 1 ampere would give only one ten-thousandth part of the torque, as just explained, and that is generally too small to start the meters. A shunt round the field can never be the right way of starting a meter. An extra armature-current is what is wanted, but that cannot well be arranged economically, at least in continuous-current meters. No residual torque arrangement can ever be accurate, however, because the starting friction is always much greater than the stopping friction. If the meter has a permanent torque which will just start it, it will never stop. If the permanent torque just allows it to stop, it will not start without an appreciable load.

Faure appears to have been the first to use a one turn motor with mercury, but as his meter has not come into commercial use it is unnecessary to describe it.

Mr. Ferranti uses a series one-turn motor meter. This inventor has struggled for years against difficulties inherent in the series motor. To make it start, he excites the field partly by a shunt circuit arranged across the terminals of the installation; or, as it may be called, a pressure circuit. The brake is supplied by the friction of the mercury and mechanism. If the torque necessary to overcome this friction varies as the speed, the field should be shunt-wound entirely, not partially. Mr. Ferranti appears to have found this out by experiment, and his latest form of meter has a constant field. In the form with the shunt field, there is a temperature error due to the variation of the resistance of the shunt.

The Teague meter is on the same principle. In this case also a one-turn, or unipolar, motor, is employed. The armature has a disk with a radial current. The outside is turned down to run in mercury, and the inside runs in a central mercury cup. It is thus a disk with radial current and mercury connections. The field in this meter is also wound partly with a constant pressure shunt, and partly in series with the armature. The shunt, as in the case of the Ferranti meter, makes the torque more nearly right at very small loads; but the series winding, unless the brake torque increases faster than the speed, seems to be wrong.

Among constant field motors Mr. Ferranti's permanent magnet form has already been mentioned.

In the Hockham meter, the field is a permanent magnet. This arrangement is most important, as it absorbs no power. The armature has several turns, and a commutator whose sections dip into mercury. The large meters are shunted by low resistance, so that a portion only of the main current is carried by the armature. This meter has no appreciable temperature error, as the low resistance shunt is platinoid, and the armature turns are wound on the Arago disk, so that it is at the same temperature, as well as of the same material, so that the effects of change of resistance cancel each other out. The mercury commutator contacts seem to be the only drawback to this type.

The Hartmann and Braun meter has a one-turn armature in the form of a disk, but the whole of the disk is not in the field, so that it acts both as armature and brake. The contacts are made by mercury cups, but the immersed parts are continuous. The field magnet is excited by a pressure current. This is, of course, a disadvantage, as it means a continuous waste of power.

The next form is due to Professor Perry. The moving system is a copper disk. This is submerged in mercury, so that the frictional resistance at the surface causes little trouble, as the rotating part is of small diameter where it emerges from the mercury. The movement of the armature is opposed by Foucault currents, but they are in the disk itself, not in a separate brake. The meter is the same in principle as the Hartmann and Braun, but the details are different. The field is notched, so that if the armature is still, the current spreads uniformly, but if the disk can move, it rotates at such a speed that the current leaves those parts of the armature which are in the strong field, and flows where there are gaps. Similarly, in the Hartmann and Braun meter, if the armature is still, the current will flow chiefly between the poles; but, if the armature is free to rotate, it will go at such a speed that the current flows round so as to avoid the field. This is merely another aspect of the Foucault current explanation; but it is always advisable to look at things from as many points of view as possible. Professor Perry's meter has a very small armature, with little friction. It should therefore start with a small fraction of a full load, and should move very slowly at all times.

Though this meter has been taken in order, and has been described as a modification of the numerous motor meters, it must not be forgotten that, in a sense, Professors Ayrton and Perry have invented nearly all the types of motor meters now in use. Some nine years ago they laid down the principles involved in their construction with perfect clearness, and though meters had been previously described, it is questionable if any one until then clearly understood the matter.

The next form to be discussed is the joule-meter, or, as it is often inaccurately termed, the watt-meter. So far coulomb-meters have alone been described. It has often been pointed out that a joule-meter is better because the consumer is supposed to be charged by the energy used, not by the quantity of electricity. On the other hand, it is urged that the pressure is kept constant, so that a colomb-meter is all that is needed. The pressure is seldom exactly as it ought to be, and the joule-meter is therefore really preferable from that point of view. To make charges really fair to the customer, the meter should read according to the light given by the lamp, that is to say, it ought to run about 5% slow for every 1% the pressure is below the normal, as the light decreases in about that proportion; and should run very slow, or even perhaps backward if the pressure is above the normal, as the supply company is then seriously reducing the life of the con-

sumers' lamps. Such meters as these are, of course, impracticable; so, other things being equal, the joule-meter is best. A joule-meter, however, must have a high-pressure circuit in which power is being wasted continuously, and it is then a question whether it is not better to use a coulombmeter, which sometimes means a loss to the one party and a gain to the other, than to have an accurate meter which involves a dead loss. Take, as a sample case, a house with fifty 30-watt lamps, the full load is 1,500 watts, the average load, say 125 watts. If the company runs the circuit at 101 volts instead of 100, and charges by a coulomb-meter at 15 cts per kilowatt hour, the price is 45 cts. per day. If the joule-meter is substituted, the charge is increased 1%. If the joule-meter itself absorbs ten watts, the cost of this, taking extra power at 4 cts. per kilo-watt hour. is 0.96 cts. per day, so that the customer has to pay more, and the company loses too. It is possible that 10 watts is an outside estimate, and it is also possible that a small cut-out, which opens the pressure circuit when no lamps are in use, may be employed.

In the Thomson-Houston meter, invented by Professor Elihu Thomson, the armature is retarded by an Arago brake, which is of large diameter and has three magnets, so that it is strong. The field magnets of the motor are two stationary coils which have no iron core, and the armature is made up of coils of fine wire which form the pressure circuit. The resistance of the small commutator does not interfere with the accuracy of the instrument, as it is in series with some thousands of ohms. The meter seems to be almost perfect, but has some drawbacks. It is a question whether the omission of iron in the field does not involve too great a loss in the fine wire circuit or excessive drop in the series coils. To reduce this is only a question of workmanship. The same form of meter is available for continuous or alternating currents, which is a great advantage, and tends to cheapness of manufacture.

The Hummel meter is the same as the Thomson in principle. The Foucault currents are produced by an electromagnet, however, which converts it from a joule-meter into a coulomb-meter. It is also possible to get much greater damping by means of an electromagnet, so a lower speed may be employed. As has been already mentioned, it is an open question whether it is best to measure the energy or the quantity; but by coupling the electromagnet in series with the armature, Mr. Hummel makes it difficult to compensate for temperature. For instance, suppose the temperature to rise enough to increase the specific resistance of copper 10%. The field, being in the main circuit, remains constant. The armature current falls 10%, so that the torque is reduced 10%. The field of the electromagnet also falls 10%, and the resistance of the copper disk increases 10%, so the Foucault currents are reduced 20% and the meter therefore increases in speed 10%.

In all the meters described, so far, the speed of the motor has been controlled by some sort of brake. In a meter designed by the author the motor is in shunt to a low resistance. The motor runs loose at such a speed that its back electromotive force is equal to the fall of pressure over the resistance. This form of meter has several advantages. The armature never takes a large current, so that the brushes are small and the friction is trifling, and mercury contacts are unnecessary. The armature is also light, as it has no copper disk, and is wound with aluminum. The chief advantage, however, is the ease of starting. Suppose the armature will start with 0.1 ampere, and suppose the armature resistance is twice the low resistance in shunt. When a single lamp is turned on, taking, say, 0.3 ampere, the armature takes 0.1 ampere and starts. A brake-meter might also be made with the same resistance, and it would take 0.1 ampere with one lamp on, which in most cases would not start it; but at full load, of, say, one hundred lamps, it would take the current of thirty-three, so the brushes would have to be large enough to carry 10 amperes; in fact, mercury becomes essential. The free motor meter, however, still takes only about 0.1 ampere, so its brushes can be very small strips of platinum or silver, giving little friction.

Many meters described are available for alternate currents. The Ferranti meter, for instance, is made with a laminated magnet; but, as already mentioned, difficulties arise because the torque does not vary as the current. The same remarks apply to the Teague meter wound for alternate currents.

The Thomson and the Schuckert meters are perfectly applicable to alternate currents. There is, of course, an error due to the time-constant of the fine wire circuit; but this is practically negligible. This is one of the very few meters that follows a simple law, and may therefore be considered trustworthy for alternate currents.

Many alternate-current motor meters, unfortunately, are still things that go round when the load is large enough, but whose speed does not appear to bear any simple relation to the current or power.

There are several alternate-current motors which have no electrical connection to the moving parts. Of these the best known is the Shallenberger, which has been most successful in America. The moving system is a small disk of iron. There are two coils round it, arranged at a small angle. One of these is in the main circuit, and the other is a closed coil. The current in the main coil magnetizes the iron, and also induces a current in the closed circuit. This latter current lags a little. The main current, therefore, induces poles in the disk, and the secondary then acts on these poles, and attempts to set the disk in a new direction, thus rotating it. The movement of the disk thus depends on angular hysteresis. If the iron is replaced by a copper disk of some thickness, Foucault currents are produced in it which convert it into a sort of solenoid, so that it is acted on in the same way as the iron, except that it moves in the opposite direction. The torque of this meter, when it has an iron disk, is thus approximately as the square of the current. Its secondary current also varies approximately as the frequency, so that the torque also varies as the frequency. If a copper disk is used, the torque varies approximately as the square of the current and as the square of the frequency, as the currents in the disk and in the secondary both vary approximately as the main current and as the frequency. The departure from the square law is because the product of the self-inductions of the open and closed circuits is much less than the square of the mutual induction. This is, of course, also the cause of the torque.

In Mr. Wright's meter the main current magnetizes the field, but closed secondary coils are wound on the pole-pieces, so that the magnetization of the ends lags a little. This causes rotation of an iron or conductive disk. This meter follows the same laws as the Shallenberger, just described. In the case of the continuous current motor meters, it was seen that the meter must either have a pressure circuit or a permanent magnet, otherwise the torque is not proportional to the current or power. In alternate currents permanent magnets are obviously useless, so a pressure circuit is necessary to give the right law. Alternate-current meters of the kind just described really require two currents differing in phase, preferably by a quarter of a period. It is not in any spirit of criticism that these remarks are offered on this and other forms of meter. It must be enormously difficult to make a meter work, whose torque varies as the square of the current, and as the frequency or as its square. In fact, a meter whose readings depend on the frequency cannot be accurate, for all the station has to do, in order to convert a heavy loss into a splendid profit, is to weaken the fields on their dynamos and run them faster. Though a station engineer would hardly be dishonest enough to run fast, he would probably be careful not to run slow. It is also but fair to mention that these criticisms are based on theoretical considerations only; the author has no figures to show that one form of meter is worse than another.

An important class of meter consists of a clock which is made to go fast or slow by acting on the pendulum. This form of meter is also one of Professors Ayrton and Perry's numerous inventions. The best known form is the Aron meter, an instrument which has deservedly come into extensive use. In this there are two clocks carefully timed. They work an index-train by means of differential gear, on the same principle as that frequently used on tricycles. If the clocks go at the same rate, the index is not moved. One pendulum has a magnet as a bob, and this is acted on by a coil carrying the main current, so that the accelerating force of gravity is assisted. This clock then goes faster when the lamps are on. This meter is not capable of the highest theoretical accuracy, because the frequency of a pendulum varies as the square root of the accelerating force, not as the accelerating force. To keep down the error arising from this, it is necessary to allow the current to modify the frequency by a very small percentage. A limit is soon reached, however, for this percentage cannot be reduced beyond a certain value, or inaccuracy in timing the clocks will cause serious errors. It must be remembered that any want of regulation of the clocks causes an error which goes on accumulating day and night, or even while the consumers are out of town. As an example, suppose a house wired for one hundred lamps, and suppose the meter calibrated to read accurately at small loads. Let the maximum number of lights often used at a time be 50, and suppose the meter arranged so that 50 lights alter the frequency of one clock 5%. The error due to the square root law is then 2%, so that the meter reads 2% wrong. Suppose the average load is equal to five lamps always on, the current has the effect of altering the speed of one pendulum ½% on an average. In order that the error dne to want of regulation of the two clocks need not be more than 2%, they must keep time with each other within .01%, that is to say, they must keep together within one minute in a week. It is difficult to make clocks as good as this, but the makers of the Aron meter seem to have succeeded. It would be better to act on both pendulums, quickening one and slowing the other; the error could then be reduced to one-half. Attention is called to this error, because it is as well that it should be understood. Such a meter as the Aron is probably more accurate than any of the meters which involve compromises between the first and second power laws.

The next class of meter is very large. A meter may consist of an ampere-meter or watt-meter and a clock. The clock moves the index-train every half minute or so, and the movement is regulated by the ampere-meter or watt-meter. For instance, the ampere-meter may carry a snail, like that used in the striking mechanism of clocks. In a clock, the tumbler falls every hour, and the number the clock strikes is regulated by the position of the snail carried by the hour wheel. Similarly, in the meter, the tumbler or feeler moves every minute or half minute, and its stroke, and therefore the movement of the index, depends on the ampere-meter. The various mechanical arrangements for doing this are numerous; but, as they are all the same in principle it is not necessary to describe the different snail meters. The chief difficulty occurs with small loads. For instance, if a meter is to read from one to one hundred lamps, the feeler must move the train even when it has only 1% of its full travel. The stroke of the feeler at no load again must be too small to move the index mechanism. If this is driven by a ratchet, for instance, the movement must be less than one tooth. It is then difficult to arrange the feeler so as to be perfectly clear of the snail; and if it does not clear the snail at no load, it may hold it and prevent registration when a load comes on. Some designers use clocks driven by springs, and others employ electrical clocks which require no winding.

Meters of this class have been designed by the Brush Co., Messrs. Brillie, Cauderay, Frazer, Hartmann and Braun, Siemens, Lord Kelvin, and many others. They can be easily arranged to work with continuous or alternating currents, and can be arranged as coulomb-meters or joule-meters.

There have been many attempts to produce heat-engine meters. This form labors under great disadvantages as to starting at light loads, for the power available is then extremely small, and many of these meters may be regarded as heat-engines which work through small ranges of temperatures at small loads, so that the efficiency is also exceedingly small. Professor Forbes has produced the most successful heat-engine meter. It consists of a resistance which heats when there is a current, and causes convection currents in the air. These work a small horizontal windmill, and this works the train. The power spent in the resistance varies as the square of the current, so the rise of its temperature varies as the square too if the air passing varies as the current, and the rise of the temperature of the air also varies as the current. The air will then carry off the heat at a rate proportional to the square of its speed, that is to say, at the rate it is generated. The efficiency of a heat-engine depending on small changes of temperature varies as the difference of temperature, so that the power available to expand and thus move the air varies as the cube of the current. If the air resistance varies as the square of its speed, as it is supposed to when the movement is quick enough to make vortices, the Forbes meter obeys theory accurately. The energy taken to work the windmill is a very small portion of the work done by the meter. The chief difficulty is to make it start with small loads. For instance, suppose the meter has a drop of ½ volt with 100 amperes, it then has 50 watts. With 1 ampere it has only 0.005 watt, and it is exceedingly difficult to make a windmill that will be moved by the draft caused by 1-200 watt. The meter, is however, a wonderful piece of work, the windmill rotating almost without perceptible friction, and being beautifully light.

There is still one form of meter to be mentioned, and that consists simply of a clock which goes only when the consumer uses power. The consumer is then charged so much per hour for the light. This kind of meter has not any chance of wide application in this country; but Mr. Aubert's meter, which is on this principle, has had enormous sales on the Continent.

(To be continued.)

SEWAGE PURIFICATION IN AMERICA.

(Continued from page 196. With inset.)

White Plains, N. Y.

The description of the sewage purification plant for the village of White Plains may be prefaced by the statement that there are three other plants in the State of New York for purifying the sewage of towns in which the same process is used. These plants are located at Round Lake, Sheepshead Bay and Coney Island, and all use the patented process and the machinery manufactured by Mr. J. J. Powers, C. E., of Brooklyn, N. Y. In this process chemicals are used to precipitate the solid matter and chlorine to deodorize and disinfect the sludge. If desired, the whole of the sewage may be treated with chlorine. The chemicals are admitted to the sewage automatically by means of floats acted upon by variations in the sewage level in the tanks.

White Plains is a suburb of New York located on the Harlem Division of the New York Central & Hudson River R. R., 22 miles from the 42d street station. Its population by the census of 1890 was 4,042, it having increased 1,661, or 69.76% since 1880. It is the county seat of Westchester County.

A public water supply was introduced in 1885 by the Westchester County Water-Works Co., the supply being pumped from "springs" to a stand-pipe. On Sept. 1, 1892, we are informed by the Moffet, Hodgkins & Clarke Co., New York, who control the water-works, there were about 15 miles of water mains and 450 taps, the consumption of water being at the rate of about 350,000 gallons per day.

The sewerage system was put in use about March 1, 1892, it having been under construction for some time previously. Mr. Wm. Landreth, M. Am. Soc. C. E., Schenectady, N. Y., made the plans for the pipe system, which were approved in 1889 by the State Board of Health of New York. Mr. Wm. B. Rider, C. E., South Norwalk, Conn., was made engineer of the work after construction started and later Mr. E. D. Bolton, C. E., now of Brookline, Mass., was made engineer and under him the works have been carried to their present stage. Mr. Geo. R. Byrne, C. E., of Byrne & Darling, White Plains, was resident engineer in charge of construction under Mr. Bolton. The changes in engineers seem to have been caused by misunderstandings between the engineers and the village authorities. We are indebted to Mr. Bolton, Mr. Powers and Mr. Byrne for courtesies extended our representative while visiting the plant; also for drawings and information.

The pipe system, it should be stated, is not yet completed. A pumping station with a Deane pump is to be erected to lift the sewage of one-tenth of the village, but about ten miles of sewers are now in use. These sewers are 8, 10, 12, 15 and 18 ins. in diameter, while the trunk sewer to and from the purification plant is 24 ins. in diameter. From April 1 to Sept. 16, 1892, Mr. Robert Jackman, Sewer Inspector, informs us 222 sewer connections were made. Prior to April 1 Mr. Jackman thinks that about 20 connections had been made.

The separate system is used, with about 50 flush tanks, mostly Rhodes-Williams with a few Van Vranken. There are about 100 manholes in the system with perforated covers. As most of the roads or streets are of dirt these perforated covers admit much dirt to the sewers increasing the amount of sludge at the purification works. In addition, the attendant in charge of the works states that when new connections are made with the sewers some house owners take advantage of the opportunity to empty their cesspools.

Some 2½ miles of underdrains were laid about on the same level as the sewers, where deemed most necessary. These underdrains discharge into brooks where most convenient.

A 24-in. trunk sewer about 7,000 ft. long leads to the purification plant which is located about 5,000 ft. from the village on the west bank of the Bronx River close by the tracks of the Harlem Division of the New York Central & Hudson River R. R. This outlet pipe is of cast iron except the last 600 or 700 ft. which is vitrified pipe. Mr. Byrne states that cast iron pipe was probably used in order to exclude ground water. The effluent passes from the purification works through about 3,000 ft. of 24-in. vitrified pipe laid parallel to the Bronx River, into which it finally discharges just below a mill dam.

The plans and sections on the accompanying inset show the arrangement of the purification works. All of the plant except the large settling tanks is inclosed in a brick building, and the large settling tanks are covered over. The tanks inside the building have special covers. The plant is duplicated in order that one set of tanks may be in use while the other is being cleaned.

The main sewer from the village terminates in the well at the end of the building, shown in the plan, Fig. 13. From this well the the sewage may be turned into either set of tanks through the gates provided for the purpose. The enlarged section of the channel through which the sewage flows when it reaches the tank decreases its velocity so that much of the solid matter would be deposited without the aid of chemicals.

As the sewage enters it receives lime from the tank shown on the plan. It then passes through the tanks in the direction indicated in the plan, Fig. 13, and as is further shown by the longitudinal section in Fig. 13 and the several cross-sections in Fig. 14. Finally it falls over the weir into the long narrow chamber next the central wall, where perchloride of iron is added. When this chamber fills it is emptied automatically by a 10-in. siphon. The varying levels in this chamber cause the discharge of the chemicals into the sewage, making this discharge automatic and maintaining a fixed relation between the quantity of chemicals and sewage, as will be described in detail in a later issue. The discharges from this siphon are received in another chamber and flow in a thin sheet over a long weir into the final settling tank, thus minimizing the disturbance of the sewage during settlement. When the large settling tank is full it also discharges by means of a siphon, passing through the outlet well or manhole to the effluent pipe already named. The last siphon is 12 ins. in diameter and all are of the Powers patent. The vertical screens shown on the plan, Fig. 13, remove the larger solid matter in the sewage. They are hung on hinges and may be swung like gates.

As the first compartment of the tank is deeper than the others, much of the solid matter settles and is retained in it, going to the bottom by its own weight. The chemicals deposit more of the sludge as the sewage flows slowly on. A sludge pit is provided in the center of each final settling tank, as shown in Fig. 13.

The sludge from the above pits and from the first compartment of the precipitation tanks may be lifted by the 4-in. centrifugal pumps through the piping shown in Figs. 15 and 16 and discharged into the opposite side for further treatment. The "primers" of the pumps are charged through 1-in. galvanized iron pipe from the force main described above. The pumps are driven by engines supplied with steam from the boiler room. These pumps were made by Arthur Van Wie, Syracuse, N. Y. The sludge can be removed finally by means of the bucket, car and tramway shown in section in Fig. 16, the tramway being shown extending the whole length of the tanks, as shown in Fig. 15. The buckets have a capacity of ¼ ton, are of steel, self-dumping and are raised by differential one-ton hoisting blocks and tackle, which runs on an overhead single-rail tramway of one ton capacity.

The two dump cars are of ¼-in. boiler iron, one ton capacity. The car tramway consists of 60-ft. rails 2 ft. c. to c., clamped to the top of iron beams.

Before the sludge is removed from the tanks it is rendered less liquid and more easily handled by the addition of "Irish bog," said to come off the top of peat beds. This bog comes in bales $2 \times 2\frac{1}{2} \times 3\frac{1}{2}$ ft. and is a good absorbent.

All the sludge which had been removed from the tanks from the time the plant was put in operation until Sept. 2 was outside the building in a pile on that date. Some of it was colored brown by the peat, some pink, presumably by the iron, but much of it had the appearance of ordinary lime and sand mortar, due of course to the lime used as a precipitant and to the further fact that much dirt is admitted to the sewers through the perforated manhole covers, as stated above. This large heap of sludge was perfectly free from odor, quite as inoffensive as a pile of mortar. Neither was there the slightest offensive odor anywhere about the works.

This lack of odor, aside from the fact that fresh sewage is not the foul matter that many people think it to be, is owing to one part of the treatment which remains to be described. In Figs. 15 and 16 the location and elevation of two pairs of chlorine generators are shown. The gas from these generators is carried through perforated lead pipes around two sides of the tanks below the sewage level. This deodorizes the sludge and stops decomposition. The chlorine is applied only to the sludge but the whole volume of sewage might be treated in the same way if a high degree of purity of effluent were desired. Chlorine, it may be stated, was considered by a committee appointed by the American Public Health Association to investigate the whole subject of disinfection as one of the best known disinfectants.

The sludge has been removed from the tanks and the chlorine used about once a month thus far. At the works it was stated that it should be removed once in two weeks. Mr. Powers, the inventor of the process, is of the opinion that it should be removed still oftener.

The tanks may be washed perfectly clean by the use of water from a small reservoir on the hill or by direct pressure from a small duplex Deane pump provided to fill the reservoir. This pump also affords fire protection for the building. The pump has 10-in. steam and 6-in. water cylinders with 10-in. stroke. A 6-in. suction pipe extends to the river, only a few feet distant. A 4-in. force main extends from the pump to the reservoir on a hill near by at a sufficient elevation to give a pressure of 47 lbs. at the works. From the force main a 2-in. galvanized iron pipe extends through the building and connects by means of 1-in. cast iron pipe with the chlorine generators and tanks. Connections are also made with all the plumbing where water is needed. Linen hose, 200 ft. in length, is provided for washing the tanks and for fire use.

The reservoir is of stone, cemented, $20 \times 10 \times 5$ ft. and, according to the specifications, covered with a building and connected by an electric indicator with the pump room.

The settling chambers inside the building have rolling covers, the wheels running on I-beams, the wheels of one set of covers running on the upper and of another on the lower flange of the beam so that the covers of one side may be rolled over or beneath those of the other (see section in Fig. 13). The specifications call for a tackle so rigged that one man can roll the cover. No such tackle was in use when the writer visited the plant and the covers were moved with difficulty.

The final settling tanks are covered with 8-in. brick arches supported by 90-lb. I-beams resting on 12-in. brick piers. Openings 6 ft. long and 12 ft. wide with sliding covers are provided in each corner of the covering of these tanks.

The bottoms of all the tanks are composed of 18 ins. of Portland cement concrete. The specifications state that all walls and piers to the height of the cross walls must be laid in Portland cement mortar and plastered with the same where brick is used; also that the entire inner surface of the tanks must be covered with two coats of asphalt paint up to the coping. Provision has been made for heating the building, including the settling tanks, by steam.

There are two lime tanks, as shown in Fig. 13, each of riveted wrought iron, $1\frac{1}{2} \times 2 \times 10$ ft. There are also two 2,000-gallon riveted ½-in. wrought iron tanks for holding the perchloride of iron. The fittings of these tanks will be described in a later issue.

A hand hoist or elevator is provided in the chemical storage room (see Fig. 15) for lifting the chemicals to the mixing tray of the chlorine generators and for lifting materials for storage in the second story.

Fig. 17 is a front elevation of the building which covers the plant. The other elevations are very plain.

Some further details of the plant already alluded to, and some facts regarding the cost of the plant, its operation and the results obtained will be given in a later issue.

TENEMENT HOUSES IN BOSTON.

The 22d annual report of the Massachusetts Bureau of Statistics of Labor treats of the tenement house population in Boston as far as relates to tenements, rooms and rent. The sanitary condition of these structures and the place of birth, occupation, etc., of tenants is to be printed as a separate report, to be issued in January, 1893. The material for these reports is gathered by a house to house visit by experienced men and women, so as to secure uniformity of method and reliable returns.

According to the U. S. Census of June, 1890, the population of Boston was 448,477, and the population for 1891 is estimated in the report at 464,751. The total number of houses in the city was 54,142, of which 36,223 were rented wholly or in part. The number of houses occupied entirely by owners was 14,788; the number of boarding houses was 1,642 and unoccupied houses was 1,489. The total number of wholly or partly rented tenements was 77,148, of which 5,483 were unoccupied at the time of the investigation.

The population in the rented houses or portion of houses was 311,396, or 67% of the total population. The number of families in these tenements was 71,665, with an average of 4.35 persons to a family. The average number of persons to a rented house was 8.60. In the suburban wards the average number of persons to a rented house was 5.96 to 14.51 in the north end. In one Back Bay precinct the average was 26.82. The largest number found

in any single house was 102, and quite a number of houses contained from 30 to 90 persons each.

The report contains an interesting comparison, in this connection, of Boston with other cities. It is as follows:

	Persons to a dwelling.		Persons to a family.	
	1890.	1880.	1890.	1880.
New York	18.52	16.37	4.84	4.96
Chicago	8.60	8.24	4.99	5.19
Philadelphia	5.60	5.79	5.60	5.13
Brooklyn	9.80	9.11	4.72	4.92
St. Louis	7.41	8.15	4.92	5.38
Boston	8.52	8.26	5.00	4.69
Baltimore	6.02	6.54	5.01	5.08

In New York 49.82% of the dwellings contain 11 persons and over, and the persons in these dwellings represent 83.50% of the total population. In Boston, however, only 24.23% of the dwellings contain 11 persons and more, and the people in these houses represent 47.80% of the total population.

From the returns from Boston it appears that 311,396 of the tenement house population occupied 342,544 rooms, an average of 0.91 persons to a room. As to rent, 1,175 families pay less than $5 monthly; 16,933 families pay $5, but under 10; 24,441 pay $10, but under $15, and 13,733 families pay $15, but under $20. Generally speaking the report indicates that there is no serious crowing in Boston, as only 1½% of the tenement house class live in houses with over 12 tenants.

THE WATER SUPPLY PROBLEM IN PHILADELPHIA.

The problems which confront officials who have charge of the water supply of a large city are serious and difficult, as is apparent from the following abstract of a recent report of Mr. Jas. H. Windrim, Director of Public Works of Philadelphia, on the water-works records for June, July and August, 1892:

The average amount of water pumped each day, consumed each day and the daily deficiency (drawn from the reservoirs) were as follows:

	Pumped.	Consumed.	Deficiency, from reservoirs.
June	174,661,000	180,620,000	5,959,000
July	170,588,000	180,660,000	9,672,000
August	178,399,000	177,378,000	none.

During these three months all the steam pumps at the several stations were in constant operation and the turbine wheels were in operation about two-thirds of the time, low water preventing their operation during 13 days. The steam pumps since June 15, 1892, have had a combined capacity of 166,500,000 gallons and the seven turbines of 33,290,000 gallons daily.

The aggregate capacity of the reservoirs is now 869,289,000 gallons (just about five days' supply at the above rate of consumption), of which 673,875,000 gallons is furnished by the East Park reservoir. This reservoir has a maximum depth of water of 25 ft. In June its actual water depth averaged about 21.5 ft.; in July, about 12.7 ft.; in August, about 11.3 ft.

June 15, 1892, a new 20,000,000-gallon pump was put in operation and another 20,000,000-gallon pump is under construction for completion April 26, 1893. A 148,000,000-gallon reservoir is also under construction and a 386,000,000-gallon reservoir, it is expected, will soon be built.

Mr. Windrim's report recommends that two 20,000,000 or 30,000,000-gallon steam pumping engines and appurtenances be added at the Spring Garden station to deliver water into the East Park reservoir, at an estimated cost of $250,000, including station and inlet; that a large new station be built and equipped to pump to the reservoir soon to be built; the estimated cost of this station is $400,000; that Councils direct water meters to be placed upon the services of all manufactories, business houses and large buildings generally; that Councils authorize the Mayor to appoint a commission of three, "to consist of a well-known hydraulic engineer, a Philadelphia business man and the Chief of the Bureau of Water, to report on a plan to secure pure water and an abundant quantity for the future of the city.

It is of interest to note in connection with the above that Philadelphia has only a few meters in use, the number in 1890, according to the Manual of American Water-Works for 1890-91, having been 522 against 170,911 taps, or only 0.3% of the number of taps. The average daily consumption per capita in 1890 was 132 gallons. Of 45 out of 50 largest cities in the United States the consumption of Philadelphia was eleventh in the rank from greatest to least consumption.

THE INVENTOR OF GAS LIGHTING.

The "Pall Mall Gazette" gives this following note in regard to Mr. William Murdoch, the well-known inventor of gas lighting and many other inventions of less importance:

It has just been decided to place in the "Hall of Heroes" at the Wallace National Monument, near Stirling, a memorial bust of William Murdoch, the inventor of gas lighting. Murdoch was a native of Ayrshire, and was born in 1754. In his twenty-third year he traveled to Birmingham, and received employment in the factory of the celebrated firm of Boulton & Watt—of which James Watt, of steam engine fame, was a chief partner. They sent Murdoch to Cornwall, and there he remained for a good many years as manager for the firm in the duchy. Murdoch invented a steam carriage for himself, in which he used to travel between the mines; and his biographers state that but for opposition from his firm he might have anticipated Stephenson with the locomotive.

From his earliest boyhood Murdoch had a turn for mechanical invention, and in regard to gas lighting is reported to have experimented with the parrot coal used in his mother's house in Ayrshire. The idea of the application of the gas to economic purposes is said to have come to him as he sat by the fire smoking one evening. The gas issuing from the coal attracted his attention. He transferred a small piece of the coal to the bowl of his pipe, closed the top and ignited the gas as it issued from the end of the stem. In 1792, just one hundred years ago, Murdoch lighted up his house and offices at Redruth, Cornwall, with gas.

The invention, for many reasons which his biographer fully explains, was never patented. Dissatisfied with his position in Boulton & Watt's establishment, Murdoch returned to Scotland and started a foundry at Old Cumnock for the making of gas apparatus; but in 1798 he went back to Birmingham as manager of the engineering works of his old firm; and in March, 1802, when a general illumination took place over the country in connection with the Peace of Amiens, the Soho Works, lighted up by gas jets, introduced for the first time to any number of the public a sight of the new light. Murdoch subsequently became a partner in the Soho firm. He died in 1839, and was buried in Handsworth church, where also rest the remains of his friends Watt and Boulton.

Engineering headquarters at the World's Columbian Exposition will probably be in the Transportation building. Mr. E. L. Corthell has applied for 1,200 sq. ft. of space there to accommodate the representatives of engineering societies who will be present to direct engineers to the points of principal interest in the Exposition.

The Niagara Falls power will doubtless benefit many other cities besides Buffalo. At Hamilton, Ont., it is proposed to utilize a large amount of electric power to operate a system of street and suburban railways and supply various small manufactories. Including the current required for lighting the city, it is claimed that as much as 15,000 HP. can be profitably used. A company is being formed by Messrs. Jno. Patterson, E. B. Osler and others to develop the scheme.

The right of the bidder to withdraw his proposal before its acceptance and receive back his deposit has recently been under discussion at Buffalo. The Union Bridge Co. was the lowest bidder for the construction of a bridge over Scajaquada Creek and in accordance with the terms of the call for proposals accompanied its bid with a certified check for $1,000. On July 8, about a fortnight after the opening of the bids, the Union Bridge Co. addressed a letter to the Board of Public Works stating that as notice had been given by the manufacturers of an advance of iron and steel prices, an early decision on their bid was requested. A reply was given that the matter was before the Committee on Bridges of the City Council. On July 27 the Union Bridge Co. sent to the Board a formal notice of the withdrawal of its proposal and asked for the return of its check, which was granted. The corporation counsel gave an opinion that the bidding company could not be held bound because its bid was not accepted, and that it had the right to withdraw its bid at any time before acceptance. Other attorneys are said to disagree with this opinion, however; and it is at least doubtful whether it could be sustained under the forms of contract in use by most cities.

The Jura-Simplon Railway Co., aided by the Federal Railway Department, has established and endowed a railway school at Biel, in the canton of Berne, Switzerland. Its object is to provide railway servants of all grades from the highest to the lowest, with a sound technical and an improved general education, befitting their respective callings. The students are from their entry divided into two groups—the one destined for mechanical and manual labor, such as engine-drivers, guards, stokers, porters, shunters, pointsmen, etc., the second or higher class, consisting of embryo station-masters, cashiers, telegraphists, inspectors, comptrollers of goods and traffic departments, clerks, etc. The instruction given is suitable for all of these, and includes both ordinary and technical education. The latter is divided under three heads—namely, the so-called "traffic service," "railway maintenance service," and "engine service"; the last, however, is not yet fully developed. The curriculum of the secular instruction comprises languages, physics, mathematics, chemistry, technical drawing and telegraphy. Students of the lower grade, already referred to, follow but one year's course of simplified study; those of the second grade cannot qualify under two years' course of lectures. Upon the opening of the school, rather more than a year ago, 44 pupils at once inscribed themselves, of whom 15 were for the manual grade and 29 for the upper. Upon the expiration of their term, however, this spring, the former found immediate employment upon the Jura-Simplon Railways, as will, doubtless, in 1893, the remaining 29. For the coming term over 100 new pupils have enrolled themselves.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

ADIRONDACK & ST. LAWRENCE.—The work of construction on the middle division between White Lake Corners and Tupper Lake is nearing completion and now only 15 miles of track remains to be laid.

WABASH.—The contract for tracklaying and ballasting the extension from Montpelier, O., to Hammond, Ind., 165 miles, has been let to W. P. Chapman & Co.

PORTLAND & RUMFORD FALLS.—This company has advertised for bids for building an extension from Mechanics Falls, Me., to a connection with the Maine Central R. R. at a point between Auburn and Danville June. Ch. Engr., Frederic Danforth, Portland, Me.

Projects and Surveys.

COLUMBUS TERMINAL & BELT.—The location of this 22-mile belt transfer railway has been completed and the right of way is now being secured. Hon. H. Sabine, of Marysville, O., is President and H. A. Schwanecke, Columbus, O., is Chief Engineer.

ANNAPOLIS & ATLANTIC.—It is stated that this company has ordered surveys to be made for the portion of its proposed line from Shelburne, N. S., northeast to a junction with the Nova Scotia Central Ry., 75 miles, with the view of immediate construction. Pres. and Ch. Engr., R. G. Hervey, 15 Wall St., New York City.

CATSKILL & TANNERSVILLE.—Chartered in New York to build a narrow gage railway from the western terminus of the Otis Elevating Ry., near the Catskill Mountain House to Tannersville with a branch line from Haines Falls to Santa Cruz Park. Among the incorporators are Chas. L. Rickerson, of New York City, Jas. Stead, of Catskill, N. Y., and Jacob Fromer, Tannersville, N. Y.

OHIO RIVER & CHARTIERS VALLEY PASSENGER.—Chartered in Pennsylvania to build a railway from a point on the Ohio River at Pittsburg, Pa., up to Chartiers Valley, Allegheny Co., Pa. Pres., Andrew Patterson, Chartiers Valley, Pa.

SOUTH SHORE.—Chartered in Pennsylvania to build a railway from Esplere, Allegheny Co., Pa., up the Ohio and Allegheny rivers to the foot of South 30th St., Pittsburg, Pa., a distance of 4⅞ miles. Pres., Robert S. Fraser, Pittsburg, Pa.

BLACK RIVER.—It is announced that the contract for building this railway from Proctorsville to Claremont Junction, Vt., 28½ miles, has been let to the Darwin Construction Co., of New York, for $595,000. Work is to begin next month. Geo. A. Ayer, Perkinsville, Vt.

Southern.—Existing Roads.

JACKSONVILLE, ST. AUGUSTINE & HALIFAX RIVER.—Tracklaying is now nearly completed to New Smyrna on the extension south from Daytona, Fla., and grading is well under way as far as Rock Ledge, Fla. It is now expected to have the road in operation to Titusville, Fla., during October.

POWELTON & POCAHONTAS.—The "Manufacturers' Record" says: "The preliminary survey for the Powelton & Pocahontas Railroad has been commenced. The road is now built and in operation from Mount Carbon station, on the Chesapenke & Ohio Ry., to Mount Carbon mines, and the extension will be from that point through east to the Norfolk & Western R. R., a distance of something over 60 miles."

SOUTH BOUND.—Rapid progress is being made on the survey of the extension from Savannah, Ga., to Hart's Road, Fla., by the engineer corps under the direction of Thomas D. Lee, of Columbia, S. C. The total length of the extension will be 107 miles, and it is expected to let the contracts for constructing 60 miles between Savannah and Jamaica by Nov. 1, and to have the whole line in operation by October, 1893.

NASHVILLE & KNOXVILLE.—The contractors, C. C. King & Bros., have a force of 500 men at work on the 11-mile extension from Algood to Standing Stone, Tenn., and the prospects are favorable for its completion by Dec. 1, as required by the contract. This will bring the road to the summit of the Cumberland Plateau, after which the construction of the further extension to the Cincinnati Southern Ry., which it is stated will be pushed immediately, will be less difficult. Ch. Engr., R. J. Moscrip, Cookeville, Tenn.

HARRIMAN COAL & IRON.—It is announced that the necessary money has been secured and that work will begin on the line from Harriman to Brushy Mt., 14 miles.

Projects and Surveys.

HALSTON VALLEY.—This company has been chartered in Tennessee to build a railway from Bristol, Tenn., to Damascus, Va., 45 miles.

Northwest.—Existing Roads.

GREAT NORTHERN.—The surveys for the extension from Park Rapids, Minn. to Leeds Lake have been completed and the engineers have begun the cross-section work.

CHICAGO, ROCK ISLAND & PACIFIC.—Grading has been commenced on the line from Lincoln to Jansen, Neb., 42 miles, and it is stated that the work will be rushed to get as much of the line graded as possible before winter.

DULUTH & IRON RANGE.—About four miles of track have been laid on the branch to the West Canton mines, 15½ miles.

CALGARY & EDMONTON.—Tracklaying on the southern extension of this Canadian road has been completed to Ft. McLeod, N. W. T.

Projects and Surveys.

TOWN OF LAKE BELT LINE & TRANSFER CO.—This company has been organized to build a belt line transfer railway at Milwaukee, Wis., and articles have been prepared for its incorporation. Only ten miles of the road, from Cudahy Station on the Chicago & Northwestern Ry. west to the Chicago, Milwaukee & St. Paul R. R., will be built at present. Among those interested are Patrick Cudahy, Geo. B. Van Norman and Leonard C. Colt, all of Milwaukee, Wis.

Southwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—The Southern extension of this railway through Indian Territory has been opened for traffic as far as Terral, on the Red River. Work is making good progress south of the Red River.

GALVESTON, LA PORTE & NORTHERN.—Eleven miles of the grading on this line from La Porte to Harrisburg, Tex., are completed, and it is expected that the entire line will be ready for tracklaying by Oct. 15. As soon as the grading is completed, the tracklaying will begin. Ch. Engr., C. G. Woodbridge, La Porte, Tex.

STUTTGART & ARKANSAS RIVER.—Tracklaying is in progress on the extension from De Witt to Pendleton, Ark.

Projects and Surveys.

NATCHEZ, ALEXANDRIA & TEXAS.—The preliminary surveys have been commenced for this proposed railway from Natchez, Miss., west through Louisiana to a point in Jasper Co., Tex. C. W. Siler, of Memphis, Tenn., is in charge of the surveys.

Rocky Mt. and Pacific.—Existing Roads.

NORTHERN PACIFIC.—It is reported that this company is about to survey an extension of the Green River & Northern branch, down Green River to mines, three miles.

COLORADO MIDLAND.—A press dispatch from Denver, Colo., says: "Gen. Man. Colbran, of the Colorado Midland, has just returned from Chicago. Mr. Colbran stated that his visit to Chicago was in connection with the building of a road from Divide, Colo., to Cripple Creek. Divide is a station near Florissant, and 28 miles west of Colorado Springs. Mr. Colbran said that if work had not already been commenced, it would be begun at once on the Cripple Creek branch. President Manvel has signed the contract for the first eight miles of road, to be completed in 60 days. The total length will be 16 miles. The contract for the remaining 8 miles will be let shortly, and 90 days will be allowed on this work, which is somewhat heavier than the first 8 miles, so that the road will be completed within five months. The average grade will be 3%, and it is estimated that a single engine will be able to haul 40 cars. The entire cost of the road and its equipment will be about $600,000. This line, Colbran says, will make the shortest route to Denver from Cripple Creek by about 75 miles."

DENVER & RIO GRANDE.—It is reported that this company will soon begin work on a branch from Crested Butte to Irwin, Colo., 9 miles. This line was surveyed about ten years ago and everything made ready for beginning construction, but no work has ever been done. It is projected to open up anthracite coal mines.

SOUTHERN PACIFIC.—Surveys are reported in progress for an extension from Lebanon, Ore., via Waterloo, to Sweet Home, Ore., about 20 miles, to open up timber lands.

SANTA FE, PRESCOTT & PHOENIX.—It is announced that work will be abandoned on this Arizona railway, upon which surveys and grading have been in progress for some months. A dispatch from San Francisco, Cal., dated Sept. 14, says: "The projectors of what is called the Santa Fe, Prescott & Phoenix R. R., in process of construction from Ashfork, south to Phoenix, Ariz., have concluded to abandon work on the line. They have found that building a railway through mountains of Arizona is beset with many unforeseen obstacles. Mountains are high and precipitous, canyons deep and broken, and water has to be developed by artifice, which is extremely expensive. Laborers and supplies must be imported, and on the line of survey there are many heavy rock cuts and deep fills required. The survey from Ashfork to Prescott is through a most desolate country, yet it amounts to nothing as compared with the heavy work to be encountered south of Prescott. There seems to be no foundation for the report that the Atlantic & Pacific R. R. was interested in the proposed line."

Projects and Surveys.

SAN FRANCISCO & ATLANTIC.—The San Francisco papers announce that all the contracts for building and equipping this road have been let, and that arrangements are complete for the floating of the $30,000,000 of bonds necessary to build the road. As projected, the line is to run from Oakland, Cal., through the San Joaquin Valley to Los Angeles, Cal., about 500 miles, and it is expected to be completed. The money is said to be provided by Eastern capitalists. Fred. Homer, of San Francisco, Cal., is interested.

SAN FRANCISCO & SANTA CLARA VALLEY.—Engineers are now in the field running preliminary lines for this road from San Francisco to Gilroy, Wash., about 80 miles. Two lines have already been surveyed and work is in progress on a third. The projectors announce that construction will begin as soon as a line is decided upon.

ELECTRIC RAILWAYS.

STONEHAM, MASS.—At a meeting Sept. 17, the selectmen granted locations to the Boston, Malden & Stoneham Electric Railway Co., and to the Stoneham & Reading. The latter road will be operated by the owners of the Wakefield & Stoneham road. The new roads will be in operation early next summer, and this place will then be crossed by four electric roads.

BUFFALO, N. Y.—The Buffalo, Kenmore & Tonawanda Electric Railroad Co. has contracted with the Field Engineering Co. for the construction of eight miles of road, to cost about $140,000. Construction will begin at once, and the road is to be finished by early spring. The company has decided to use 60-lb. rails, and 362 ties to the mile. The power-house will be midway between Buffalo and Tonawanda, and will contain a 150-HP. engine, from the Lake Erie Engineering Works; also two 60-HP. boilers, and two 60-HP. Edison generators. The cars will be of the Brill make, 21-ft. body and 29 ft. over all, and each will be provided with a Thomson-Houston waterproof high-speed motor, capable of running 35 miles an hour.

SHENANDOAH, PA.—The injunction against the electric railway has been dissolved, and the construction of the road will be resumed.

SAVANNAH, GA.—The Savannah Electric Railroad Co. will extend its road to the railroad wharves, at a cost of about $50,000.

CHICAGO, ILL.—The City Railway Co. has decided to put electric lines on 35th St., 47th St., 61st St., and 63d St., and will try to have the new roads in operation by Dec. 1. The Chicago & Southwestern Electric Railway Co. was incorporated Sept. 15, to bring Oaklawn into closer connection with Evergreen Park and the South Chicago district; total length, 6½ miles. The principal promoters are B. F. Jacobs, O. K. Munson, and Louis Menage, Minneapolis, Minn.; capital stock, $250,000.

SIOUX CITY, IA.—The City Council is considering the granting of a franchise to the Morning Side Street Railway Co., to build an electric line to connect with the elevated line at Leech St., and extend to St. Aubin Place, the construction to commence by June 1, 1893. W. M. Joy and A. J. Rederich, are interested.

DENVER, COLO.—Engineers are investigating a proposed extension of the Westminster road to Boulder and Louisville, a distance of 40 miles. The proposition is reported as meeting with much favor.

SAN FRANCISCO, CAL.—The San Francisco & San Mateo Electric Railway Co. has applied for a new franchise, which includes the use of overhead wires on the present route, and on several new branches.

BRANTFORD, ONT.—Jones & Co., Toronto, have been awarded the contract for power-house for the electric street railway.

TORONTO, ONT.—The Toronto & Scarboro Electric Railway Co. has decided to push the work this fall along the Kingston road, and through East Toronto village. The route will be decided upon Oct. 3.

NEW COMPANIES.—Kimball Electric Co., Chicago, Ill.; $5,000,000; to promote a new system of electric traction; patents owned by D. E. Kimball, Topeka, Kan.; Chas. H. Tallmadge, A. L. Allen, W. R. Payne, Hazleton & South Side Electric Railway Co., Hazleton, Pa.; $75,000; to operate between Hazleton, Jansesville, Auden'ried and Pleasant Hill; Pres., Alvin Markle. Hazleton & North Side Electric Railway Co., Hazleton, Pa.; $25,000; to operate between Hazleton, Harleigh, Drifton and Freeland; Pres., Alvin Markle. Pottsville, Cressona, Schuykill Haven & Orwigsburg Electric Street Railway Co., Orwigsburg, Pa.; capital paid in, $15,000; Pres., John T. Schcener. Oakland & Piedmont Electric Railway Co., Alameda, Cal.; $500,000; F. H. Meyers, W. M. Rauk, S. H. Bass. Leffler Electro-Magnetic Railway Co., Minneapolis, Minn.; $1,000,000; A. H. Brice, P. W. Leffler, F. R. Lane.

HORSE AND MOTOR RAILWAYS.

NEW ORLEANS, LA.—A franchise for a street railway has been sold at auction by the City Comptroller and purchased by Judah Hart for $500. The franchise runs for 25 years after which the entire system shall revert to the city, and the specifications stipulate that improvements to the extent of $500,000 shall be made by the successful contractor.

HUNTINGTON, IND.—The Huntington Street Ry. Co. has been organized and will petition for a franchise. The company desires to build a line this fall. Pres., Dr. G. H. McLinis; capital stock, $100,000.

NEW COMPANIES.—Clearfield & Curwensville Passenger R. R. Co., Clearfield, Pa.; $100,000; Pres., J. J. Patterson, Mifflintown, Phillipsburg & Houtzdale R. R. Co., Osceola, Pa.; $100,000; Pres., J. J. Patterson, Mifflintown. Lakeside Street R. R. Co., Fort Wayne, Ind.; $50,000; R. T. McDonald, H. J. Miller, A. D. Guild.

HIGHWAYS.

GEORGIA.—The $40,000 required to build the proposed road from Quitman to McDonald has been raised and it is expected that the road will be constructed.

ALABAMA.—The Board of Revenue of Montgomery county will receive bids until Sept. 26 for six miles of chert on the Greenville road, and six miles on the Woodley road. C. A. Allen, Clk. of Bd., Montgomery, Ala.

MISSOURI.—Bids will be received at the office of the County Surveyor, Kansas City, until Sept. 29 for the macadamizing of the Kansas City & Raytown road from Leeds to Raytown.

WATER-WORKS.

New England.

GREENVILLE, ME.—It is reported that an estimate places the cost of works, with a supply from Sawyer Pond, at $20,000.

CHICOPEE, MASS.—The city has voted 243 to 24 to introduce a supply from Cooley, Morton, School House and Fuller Brooks and 226 to 38 to buy the property of the Willimansett Water Co.

IPSWICH, MASS.—The town is considering the introduction of a water supply.

LYNN, MASS.—A high service pump at the present station and a high service reservoir are proposed; estimated cost, $33,000.

MALDEN, MASS.—The Water Board has been authorized to sell $50,000 of bonds.

Middle.

CHESTER, N. Y.—Bids for material and labor for works will be received until Oct. 7, as stated in our advertising columns.

EAST SYRACUSE, N. Y.—It is estimated that works can be built for $70,000. Address Water Commissioners.

MIDDLETOWN, N. Y.—Iron mains are to be laid in place of cement.

RIVERHEAD, N. Y.—The Riverhead Water Co. has been incorporated; $15,000. Directors, Geo. W. Cooper, Timothy M. Griffing and others. Water will be pumped to a 77,500-gallon tank, 95 ft. above the ground. The pumps will be operated in connection with a grist mill.

SCHENECTADY, N. Y.—It is stated that Engr. S. E. Babcock, Little Falls, has reported that a good new supply could be obtained from the Sacondaga River.

SYRACUSE, N. Y.—The Council has authorized the issuance of $500,000 3½% water bonds for the new supply.

ALLEGHENY, PA.—Councils have voted to extend the intake pipes further up the river at a cost, as reported, of $150,000.

CATASAUQUA, PA.—It is reported that a contract for a filtering plant has been awarded to the Moore Filter Co., Holyoke, Mass.

HANOVER, PA.—Nov. 8 the people will vote on buying the works of the Hanover Water Co.

NEW WILMINGTON, PA.—The New Wilmington Water Supply Co. has been incorporated; $10,000; Treas., J. W. Dobbs.

SALTSBURG, PA.—It is reported that a vote on building works will be taken in November.

LONACONING, MD.—The people have voted against issuing $40,000 of bonds for works.

MIDDLETOWN, MD.—Engr. M. P. Paret, Baltimore, informs us that the highest bid, received Sept. 15, for works was from J. P. Morgan & Co., Baltimore, $14,057, and the lowest from I. Owen Patterson, Baltimore, $12,150. New bids will be received Sept. 21 from some of the lowest bidders, the bids being above the money available, and the plans having been slightly revised since.

Southern.

GREENWOOD, MISS.—It is reported that water and electric lighting plants will be built by W. R. Yeargin, Dyersburg, Tenn.

SHREVEPORT, LA.—It is reported that the company will improve its works. E. A. O'Geran is now Superintendent.

LUDLOW, KY.—Bids will be received until Sept. 29, by A. V. C. Grant, Cy. Clk., for 406 tons 12 to 4-in. cast iron pipe; 5 tons specials; 69 12 to 4-in. valves, including boxes; 2 blow-offs; 5 double 6-in. and 15 single 4-in. hydrants; laying 17,850 ft. of above pipe, setting valves, etc., and laying 1,000 ft. 3-in drain tile; 50 cu. yds. rubble masonry, and an unstated amount of brick and masonry and concrete. Bonds to the amount of $25,000 will be issued.

North Central.

BOWLING GREEN, O.—The Bowling Green Water Co. has been incorporated; $75,000.

LEBANON, O.—Bids for works are wanted as stated in our advertising columns.

BRAZIL, IND.—It is reported that the city will add a reservoir to the works.

EDINBURG, IND.—Engr. J. J. Hainsworth, Franklin, will make plans for works here.

MARTINSVILLE, IND.—Propositions for a franchise are being received. W. H. Miller and C. G. H. Goss are on the committee.

NAPERVILLE, ILL.—Works to cost $100,000 are reported as to be built.

CUMBERLAND, WIS.—A vote will be taken on issuing $10,000 of bonds for works.

Northwestern.

BASSETT, NEB.—Sept. 24 bids will be received for building works. O. M. Loomis, Village Clerk.

BEAVER CITY, NEB.—Bonds for works have been voted.

HOT SPRINGS, S. DAK.—The Catholicon Springs Co. has applied for a 20-years franchise.

Southwestern.

COLUMBIA, MO.—It is reported that the Council will call an election to vote on establishing works.

MONETT, MO.—A contract for works has been let to Chas. F. Sturdevant, St. Louis, and Geo. W. Sturdevant, Chicago, for $14,366.

ST. LOUIS, MO.—Bids will be received until Oct. 11 for furnishing and delivering at Bissell's Point, about 630 tons of 36 and 12-in. cast iron coated pipe; 35 tons of specials; 1 36-in. check valve, and 2 36-in. stop valves. Geo. Burnet, Pres.; E. S. Foster, Secy., Bd. Pub. Impts.

LA JUNTA, COLO.—The Council has passed an ordinance authorizing the purchase of the works for $32,000, it is reported. The Santa Fe R. R. Co. owns the works.

Canada.

WINNIPEG, MAN.—The City Engineer has estimated the cost of material for new city works at $108,750 and the Mayor and Ald. Cockburn have been instructed to solicit bids.

IRRIGATION.

CUSTER CO., COLO.—Bids will be received until Oct. 1 by State Engr. J. P. Maxwell, Denver, for the construction of a dam on Hardscrabble Creek. The amount available for the work is $9,250.

PERRIS, CAL.—Bids will be received until Oct. 4 for 57,797 ft. of 15 to 10-in. No. 14 double riveted steel pipe; 7,014 ft. of 9-in., No. 14; 15,630 ft. of 8 to 5-in. No. 14 pipe; 24 2-in. air valves; gates, crosses, tees and outlets. Payment will be made in bonds of the Perris Irrigation District, at par. W. F. Perry, Secy.

BRIDGES, TUNNELS AND CANALS.

LITTLE FALLS, N. Y.—The Town Board has authorized the erection of a bridge at Ann street, to cost $25,000.

BRADDOCK, PA.—The West Braddock Bridge Co. has been chartered to build a bridge over the Monongahela River at this place. The directors are: Chas. Jutte and Geo. W. Theis, of Pittsburg, Pa.

KANSAS CITY, MO.—The prospects are that the proposed bridge over the Kaw River at Ohio Ave., projected by the Martin Belt Line, will be erected in the near future.

SEWERS.

COBLESKILL, N. Y.—The contract for a sewerage system has been awarded to W. M. Johnston, Canajoharie, and C. E. Walker, Amsterdam, at about $16,600.

NEW PALTZ, N. Y.—The citizens have decided that a system of sewerage should be constructed, and a Board of Sewer Commissioners has been appointed.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Sept. 27 for ten sewers.

TROY, N. Y.—Several additional sewers have been ordered.

WASHINGTON, D. C.—The District Commissioners will receive bids until Oct. 1 for constructing sewers in the District of Columbia.

MANCHESTER, VA.—The City Council is considering an ordinance granting a franchise to John C. Robertson and others, to construct a sewerage system in the city.

CLEVELAND, O.—The Board of Control will receive bids until Oct. 12, for a sewer in Detroit St. with an outlet to the Cuyahoga River.

MARIETTA, O.—Plans and profiles for a general sewerage system have been submitted by John W. Hill, Cincinnati.

XENIA, O.—We are informed by W. D. Riddell, Cy. Engr., that a new sewer system is to be constructed.

HUNTINGTON, IND.—Bids are asked until Oct. 24 for the Flint Creek sewer and drain. H. H. Wagoner, Cy. Engr.

BAY CITY, MICH.—The Council has voted to construct a 26×39-in. brick sewer in 18th St., to the river; rough estimate, $10,000.

ISHPEMING, MICH.—The Sewerage Committee has been instructed to advertise for bids for the trunk sewer, and to employ a competent man to superintend the construction.

MUSKEGON, MICH.—Plans have been prepared for a sewerage system, to cost about $10,000, and the main sewer is to be constructed this fall and winter.

NEGAUNEE, MICH.—The Committee on Sewers has been instructed to advertise for bids for 10 to 22-in. tile for the trunk sewer. An expert is to be employed to assist in preparing plans and specifications for the system, which is estimated to cost about $35,000.

JOLIET, ILL.—The City Clerk will receive bids until Sept. 26 for the entire improvement of Cass St., including sewers.

LOMBARD, ILL.—Plans for a sewer system, to cost about $20,000, have been prepared by Prout, Burnham & Russel, Wheaton.

MINNEAPOLIS, MINN.—Andrew Rinker, Cy. Engr., has prepared estimates for sewers in 44 streets.

DAVENPORT, IA.—The contract for a brick sewer 3,352 ft. long, in Fillmore St., has been awarded to Edwards & Walsh, at $14,709.

DES MOINES, IA.—The Board of Public Works will receive bids until Oct. 8 for five 12 to 18 in. pipe sewers; also for a 48-in. double-ring brick sewer in East First St.

OMAHA, NEB.—The issue of sewer bonds for $100,000 will be voted upon at the November election.

OMAHA, NEB.—The Board of Public Works will receive bids until Sept. 30 for sewers in three districts.

ST. LOUIS, MO.—The following lowest bids have been received: Wycoff & Creal, $16,683; Hussey & Teese, 2 contracts, $23,072; R. J. Shea, 2 contracts, $29,290; I. G. Eyerman, $10,212.

DENISON, TEX.—Plans and surveys are being made by Mr. McWillie, Cy. Engr., for sewer extensions, estimated to cost about $11,000, unless much rock is found.

DENVER, COLO.—The Board of Public Works will receive bids until Oct. 8, for certain sewers.

LOS GATOS, CAL.—The special committee to report on a sewer system has recommended that 6 and 8 in. vitrified pipe sewers be constructed in several streets.

PORTLAND, ORE.—The lowest bid for the sewers in the East Side was that of R. S. Reilly, $67,873. The system will be about four miles in length and includes 2,500 ft. of brick sewers.

STREETS.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Sept. 30 for paving two streets with cobble stone.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Sept. 27 for paving four streets with granite blocks on concrete.

TROY, N. Y.—The bids for brick paving have been rejected owing to a change in the specifications and the work will be readvertised. The Hudson River Stone Supply Co., Storm King, has offered the city 400 yds. of broken blue stone or granite for street work, the city to pay the cost of transportation, and the offer has been accepted.

AMBLER, PA.—The Town Council has voted to macadamize Lindenwold Ave. a distance of 1,500 ft.

CINCINNATI, O.—The Board of Administration will receive bids until Oct. 11 for the improvement of Eighth St. in connection with the viaduct. The work includes filling, curbing, paving, etc.

YOUNGSTOWN, O.—Two bids were received for paving Madison Ave., 9,534 sq. yds., as follows: Barber Asphalt Paving Co., sheet asphalt on four inches of concrete, $26,487; F. E. Gribben, asphalt blocks, $25,591.

XENIA, O.—W. D. Riddell, Cy. Engr., informs us that the city is about to pave the principal streets.

CHICAGO, ILL.—The Commissioner of Public Works is about to advertise for bids for paving nearly 200 streets and alleys.

VENICE, ILL.—The Village Board has ordered the immediate improvement of Main St., at an estimated cost of $27,000.

KANSAS CITY, MO.—Bids for paving several streets and alleys with brick have been rejected, and the work will be readvertised.

ST. LOUIS, MO.—The following lowest bids have been received: Barber Asphalt Paving Co., 2 contracts, $50,380; Francis Construction Co., 3 contracts, $9,330; Schneider Granite Co., 3 contracts, $18,366.

OMAHA, NEB.—The Board of Public Works will receive bids until Sept. 29 for paving five streets with asphalt, granite, sandstone, or brick; and until Sept. 30 for grading two streets. At the November election the city will vote on the proposed issue of paving bonds for $100,000.

SEATTLE, WASH.—The contract for grading Broadway has been awarded to I. Liberman at $14,526.

ELECTRICAL.

HACKENSACK, N. J.—The Improvement Commission will receive bids for 200 to 250 lights, of 32 c. p., or the equivalent gaslight. The present contract for street lighting was made three years ago, and will expire Nov. 1. It provides for 200 incandescent lights of 30 c. p., at $15 per year per light, each light to burn all night.

HOBOKEN, N. J.—The contract with the Hudson Electric Light Co. for street lighting has been renewed for a period of ten years. This company furnishes North Hudson with electric lights, and is reported as trying to secure a contract for lighting the streets of Jersey City.

LEESBURG, VA.—The Mayor will receive bids until Oct. 8 for lighting the streets by electricity.

GREENWOOD, MISS.—It is reported that a plant will be erected by W. R. Yeargin, Dyersburg, Tenn.

CLINTON, MICH.—The Board of Trustees will receive bids until Oct. 5 for an arc and incandescent lighting plant.

JACKSON, MICH.—A franchise has been granted to the Fort Wayne Electric Light Co., whose capital stock is $100,000. It will light residences principally.

EDWARDSVILLE, ILL.—The contract for lighting the streets by electricity has been awarded to the N. O. Nelson Manufacturing Co. at $80 per lamp per year for lights of 2,000 c. p., and about 1 ct. per hour for each incandescent light of 16 c. p., with reductions as the number of lights is increased. Other bids were $85 and $125 per year for lights of 2,000 c. p.

EAU CLAIRE, WIS.—The City Clerk will receive bids until Nov. 15 for lighting the city. See advertisement.

JEFFERSON CITY, MO.—The only bid received for street lighting was that of the Jefferson City Light, Heat and Power Co., as follows: For 30 or more arc lights, contract for 10 years, $87 per light per year for lights to burn until 1 o'clock, and $117 for all night lights; contract for 8 years, $90 and $123; contract for 5 years, $114 and $138.

SAN BERNARDINO, CAL.—The contracts for 40 or more arc lights of 2,000 c. p. each has been awarded to a new company represented by F. G. Cartwright and C. R. Lloyd, at $11 per light per month, each light to burn all night.

BRANTFORD, ONT.—The citizens have voted in opposition to the proposed municipal plant, and the Brantford Electric Light Co. has accepted an offer of 23½ cts. per light per night for 35 lights for one year. The company's bid was 23½ cts. for 60 lights for five years.

NEW COMPANIES.—People's Electric Co., Braddock, Pa.; $35,000; Treas., S. D. Hamilton. Dunlap Electric Co., Brownsville, Pa.; $5,000; Treas., Wm. Parkhill. Cooperstown Electric Co., Cooperstown, N. Y.; $12,500; O. R. Butler, Cooperstown; R. E. Drake, P. T. Brady, Syracuse. Electric Power Company of Wilmington, Chicago, Ill.; $1,000,000; Chas. B. Holmes, J. E. Truitt, James Anthony. Heppner Water and Light Co., Heppner, Ore.; H. V. Gates, Jas. D. Hamilton, T. W. Ayers, Sr.

CONTRACT PRICES.

STREET WORK.—Sewickley, Pa.—We are informed, by F. A. Dunham, Engr. in Charge, that the contract for the improvement of Beaver St. has been awarded to F. P. Sawders & Co., Pittsburg, as follows: Excavation, 4,290 cu. yds., 20 cts. per cu. yd.; paving with brick, 17,350 sq. yds., $1.34½ and $1.43½ per sq. yd., with concrete foundation, $1.48 and $1.57 with broken stone, $1.24 and $1.33 with present stone foundation; curb, 200 lin. ft., 60 cts. per lin. ft.; curb reset, 8,550 lin. ft., 9 cts.; curb redressed, 9,000 lin. ft., 5 cts.; drain tile, 10,000 lin. ft., 5 cts.; iron gutter crossings, 20,000 lbs., 2½ cts. per lb.

Brooklyn, N. Y.—The itemized prices of the lowest which we noted last week as aggregating $581,624, bids received for paving 23 streets with granite blocks, ranged as follows: Paving, $2.15 to $2.30 per sq. yd.; improvement, 10 to 20 cts. per lin. ft.; new curb, 15 to 75 cts.; redressed curb, 5 to 70 cts.; blue stone bridge, 1 to 45 cts. per sq. ft.; granite bridge, 40 to 60 cts.; reflagging, 1 to 5 cts.

Galveston, Tex.—The Board of Public Works has recommended the following bid for acceptance, for paving 19 blocks and intersections with 5-in. pine blocks, and 15 blocks with 6-in. pine blocks; blocks to be of hard yellow pine with 10 lbs. of dead oil per cu. ft. of wood, and thoroughly creosoted. Cotter, McHenry, Ketchum & Co., surface grading, 10 cts. per. sq. yd.; 6-in. block paving, $2.38¾ per sq. yd.; 5-in. block paving, $2.18¾.

SEWERS.—Sewickley, Pa.—The contract for sewers in Beaver St. has been awarded to Corcoran & Connell, Pittsburg, at the following prices: 6-in. house connections, 2,482 lin. ft., 40 cts. per lin. ft.; 8-in. pipe sewer, 1,595 lin. ft., 55 cts.; 10-in., 2,930 ft., 60 cts.; 12-in., 525 ft., 66 cts.; 15-in., 1,018 ft., 48 cts.; 18-in., 380 ft., 59 cts.; 12-in. pipe connections and catch basins, 150 ft., 45 cts.; 8-in. Y's, 40, 50 cts.; 10-in., 75, 80 cts.; 12-in., 31, $1; 15-in., 8, $1.20; 18-in., 3, $1.60; 4-in. drain tile, 1,000 ft., 4 cts.; 11 catch basins, $25 each; 10 lamp holes, $6; 6 manholes, $48; 2 flush tanks, $75. F. A. Dunham, Engr. in Charge.

DRAINAGE.—Keokuk, Ia.—The contract for draining Lima lake has been awarded to W. L. Rose, at 10 cts. per cu. yd., and 1 ct. additional for 100 ft. overhaul. The work includes raising the cross levee of the lake 2 ft. and widening it 8 ft. at the base on the inside, about 22,655 cu. yds., and filling the break at Conner's slough, 5,000 to 7,000 cu. yds.

PENSTOCKS, TURBINES, ETC.—Austin, Tex.—The following are some of the lowest bids recently received by the Board of Public Works: J. Waterson, Austin, Tex., earth excavation for wheel pits and power house foundations, 30,000 cu. yds., 33 cts. per cu. yd.; rock excavation, 9,500 cu. yds., 75 cts and $1; ashler granite masonry, 369 cu. yds., $20; rubble limestone masonry, 3,000 cu. yds., $5.50; painting two coats, 15,000 sq. yds, 20 cts. Riter & Conley, Pittsburg, Pa., rack bars, frames and bolts, 70 tons, $93.80 per ton in place; penstock branch and feeder pipe, 360 tons, $97.55; penstock manholes, 13, $15 each. Stillwell & Bierce Manufacturing Co. and Smith & Vail Co., Dayton, O., head gate castings and bolts, 29 tons, $133 per ton in place; cast iron quarter turns and rings, 17 tons, $136.76; 4 pairs horizontal turbines, pulleys and bearings, $3,600; 2 pairs 4,000,000-gallon pumps, gears, connecting pipes and fittings, $9,200.

MISCELLANEOUS.

DAM.—Laconia, N. H.—The mill owners of this village have decided to employ a competent engineer to prepare surveys and plans for a new dam in the Merrimack River.

DRAINAGE.—London, Ont.—It is proposal to drain Pelee Island, and plans have been submitted by Mr. Newman Engr. The estimated expense is $22,500.

BONDS.—Sault de Ste. Marie, Mich.—The St. Mary's Water Power Co., will issue bonds for $750,000.

GAS LIGHTING.—South Orange, N. J.—The Citizen's Gas Light Co. offers to renew its present contract for three years at $20 per lamp per year, the present rate being $22. A special meeting will be held Sept. 26 to consider the subject.

GAS COMPANIES.—Cooperstown Gas Co., Cooperstown, N. Y.; $12,500; Oliver R. Butler, Cooperstown; Robert E. Drake and Paul T. Brady, Syracuse. Joliet Vulcan Gas Co., Chicago, Ill.; $100,000; H. S. Gillette, S. D. Cameron and Wm. H. Taylor.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have built 6 compound engines for the Central Ry., Brazil, following the order for 17 which were shipped in the spring. The Brooks Locomotive Works, Dunkirk, N. Y., have an order for 17 consolidation and 8 six-wheel switching engines for the Great Northern. The Rhode Island Locomotive Works, Providence, R. I., have built a two-cylinder compound (Eng. News, Dec. 12, 1891) ten-wheel engine for the Northern Adirondack. The Michigan Central has built a ten-wheel passenger engine for heavy express service; it has cylinders 19×24 ins., and six driving wheels 66 ins. diameter, and weighs with tender 120 tons; it is expected to haul trains of 15 sleeping cars at high speed.

CARS.—The J. G. Brill Co., Philadelphia, Pa., has built 12 electric motor cars for the Montreal Street Ry. Co. The Jacksonville, St. Augustine & Halifax River has purchased 2 buffet cars 70 ft. long, with six-wheel trucks, to seat 33 passengers and costing $10,500 each; also 5 passenger cars costing $5,100 each, 4 combination baggage and smoking cars, 2 mail cars and 2 baggage cars. Chicago Car Appliance Co., Chicago, Ill.; $100,000; John E. Turney, Hiram V. Reed and O. S. Reed. The Thatcher Automatic Dump Car Co., of New York, has been incorporated in West Virginia; capital stock, $2,000,000.

PUMPS.—H. R. Worthington, N. Y., has been awarded a contract for two 500,000-gallon pumping engines for the Northport, N. Y., water-works; a 1,000,000-gallon pumping engine for Whitestone, N. Y.; and a 1,000,000-gallon triple expansion and 750,000-gallon power pump, with boiler and piping complete, for Asheville, N. C. The Laidlaw & Dunn Co., Cincinnati, O., has been awarded the contract for compound and deep well pumps, boilers, etc., for the water-works at Wyoming, O.

THE SERVIS TIE PLATE.—We have received from the Q & C Co., manufacturers of the Servis tie plate, a letter concerning certain late charges made that accidents had occurrer because of the track spikes shearing these plates. The company named totally denies the truth of these charges, and, further, states that a letter sent to it inquiring into these rumors has been used by those interested in a rival plate, as expressing the sentiments of the writer; whereas it was simply a letter of inquiry brought out by rumors. Our readers must determine for themselves the value of such testimony in the case in question.

THE KING BRIDGE CO., of Cleveland, O., has the contract for large shops near Buffalo, for the Gould Coupler Co. The plant will cost about $160,000. It will be erected in the new suburb of Depew, beside the New York Central shops.

THE BERLIN BRIDGE CO. has designed and is erecting an additional iron building, 240 ft. long, for the United States Projectile Co., of Brooklyn, N. Y.

COMPANIES.—Medusaline Stone Co., Chicago, Ill.; $250,000; Treas., J. Kenney, A. A. Babcock, R. M. McKinley. Durolithic Stone Co., Ill.; $200,000; F. J. Kenney, A. A. Babcock, R. M. McKinley. American Brake Beam Co., Chicago, Ill.; $2,500,000; N. B. Judah, M. L. Willard, Eugene H. Dupee. Trinity River Navigation Co., Dallas, Tex.; $300,000; to construct steamers and open and navigate Trinity River to deep water at Galveston; Joseph Huey, F. M. Cockrell, Phillip Conger. Chicago Equipment Co., Chicago, Ill.; $1,000,000; to deal in engines, cars and railway supplies; R. H. Pugh, A. H. Dunham, H. R. Durkee. Tramway Railway Co., Pittsburg, Pa.; $1,000,000; C. H. Read, Henry Higinbotham, C. McKee. Boss Grip Lock Nut Co., Denver, Colo.; $300,000. American Nut Lock Co., St. Louis, Mo.; Pres., J. A. Inslee; Secy., J. A. Harrison.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $16.50 to $17 for iron and $14 to $14.50 for steel. Pittsburg: $30. Chicago: $31 to $32.50; old rails, $17.75 to $18.75 for iron and $14 to $14.50 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.65 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 60 and 10% and 50 and 10% on black and galvanized butt-welded; 70% and 60% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $13 to $15.50. Pittsburg: $13 to $14.25. Chicago: $12.85 to $15.

LEAD.—New York: 4.12 to4.15 cts.; Chicago: 3.95 to 4 cts.; St. Louis: 3.95 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts. for shell; 2.25 to 2.65 cts. for flange, 3 to 3.25 cts. for shell; 2.25 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.05 cts. for large lots, and 2.1 to 2.15 cts. for small lots; channels, 2 to 2.05 cts for large lots and 2.1 to 2.15 cts. for small lots; angles, 1.85 to 1.95 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2.1 to 2.15 cts.; universal mill plates, 1.8 to 1.85 cts.; for steel sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.85 to 1.95 cts. for tank; 2 to 2.15 cts. for shell; 2.1 to 2.2 cts. for flange; 3.6 to 3.75 cts. for firebox. Chicago: beams, 2.25 to 2.35 cts. for large lots, and 2.5 cts. for small lots; channels, 2.25 to 2.50 cts.; angles, 2 to 2.15 cts.; tees, 2.25 to 2.4 cts.; universal plates, 2 to 2.15 cts.; steel plates, 2.15 to 2.4 cts. for tank and shell; 2.5 to 2.75 cts. for flange.